QUANTA, ALTERITY, AND LOVE

Quantum Physics and Philosophy

Mark Dreher

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Abstract

[1]

Starting in the 20th century, quantum physics and philosophy have found common ground from ancient intuitions of chaos. Many of the world's greatest quantum physicists have written extensively about the philosophical implications of the astounding findings of quantum physics. This book is a comprehensive study of the history of philosophy and science which has led civilization to an unfathomable precipice. This book goes into great detail about the current findings and research of quantum physics, including quantum intelligence. Many people are not aware of the radical implications of quantum physics. This applies not only in areas of technology but in practical day-to-day commonsense. Social mores reduced and justified by commonsense have been hollowed out from the inside culturally by history's incapacity to take hold of findings in physics and philosophical directions in the 20th century. Incredibly, in the same century, philosopher Emmanuel Levinas concurrently has brought us before another radical alterity (otherness) in his radical externality and responsibility before the other who faces us.

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1 kyoshino, *The Big Bang Explosion in Deep Space*, stock photo, Getty Images, accessed [Date], gettyimages.com.

Getty Images (also distributed via iStock)

Preface to the eBook

I have interests in many areas of philosophy and science. In science, quantum physics is at the top of my list. Recent advances in quantum physics are of interest to me. My past research in philosophy, the work of Emmanuel Levinas (1906-1995), has led me towards the occasion of this book in which quantum physics might be used as a tool to help us put classical science and its lingering 'common-sense' assumptions into perspective. Once we can do that, it may be possible to bring us towards an unbridgeable gap - radical externality. Levinas' work is not yet another, tired metaphysics of a God or gods or of our assumptions of self and other but something entirely different.

History has led us to assume that we are all thinking 'things', fundamentally separate from each other and others are built just *like* us. Levinas uses the phrase 'radical alterity' (otherness) to distinguish the other as quite different from thinking things. Quantum physics informs us of something entirely different from our inherited common-sense notions of 'reality'. Levinas' 'radical exteriority' refers to the other who faces us in a radically different fashion. More importantly, Levinas finds a vastly different kind of ethics and responsibility to the other from any previous philosophical traditions of ethics. I find Levinas to be very timely at this moment in history. One important thing to remember, which I will revisit in the Epilog at the end of this book and only after much more background in the previous text, is that I am in no way trying to draw a cause and effect or any kind of relationship between quantum physics and Levinas. That would be a tired old reading that this text will not maintain… to the contrary!

In the world of physics, I am fascinated by quantum theory and in particular, quantum entanglement. Einstein (1879-1955) called quantum entanglement 'spooky action at a distance'. Erwin

Schrödinger (1887-1961), credited with discovering the quantum wave function, wrote of quantum entanglement, "*I would not call [entanglement] one but rather* ***the*** *characteristic trait of quantum mechanics, the one that enforces its entire departure from classical lines of thought.*" [1] The quantum wave function describes entanglement. However, the wave function is not space, time, existence, anything classical physics knew about, or anything that can relate to our commonsense notions of 'reality'. The quantum wave function is bizarre beyond belief. These volumes will explore ideas of the greatest physicists in the 20th century through their own scientific and philosophical books and papers on what they considered to be the expansive implications of quantum physics to philosophy. These famous physicists include Einstein, Schrödinger, Bohr, and many others up to the present day. Quantum physics and philosophy are necessarily intertwined. These geniuses understood this. They spoke, wrote, reflected as deeply and eloquently on philosophy as any of history's greatest philosophers.

In quantum wave functions, particles do not exist as any 'thing'. It is quite difficult to find conventional words and ideas to explain the oddity of the quantum wave function. Physicists use mathematics to describe this spooky, nether state. Although the quantum wave function has no matter, nothing physical about it, we can analogously imagine it as both - simultaneously, waves and particles. However, that is more of a mental device for those of us who are not quantum physicists. Many working physicists feel more professionally comfortable simply referring to the quantum wave function as mathematics. First, the wave function is not a local mathematical anomaly taking place in one specific location in spacetime. Many physicists believe spacetime, everything we know or think about 'reality' emerges from the quantum wave function. One example - ever hear of the Big Bang singularity?

A very weird characteristic of the quantum wave function is what physicists call the 'observer effect'. In the most highly isolated experiment from the environment as is possible, the quantum wave

function cannot be severed from the observer, from any kind of observation! Additionally, the quantum wave function can mathematically give us a range of probable ideas of what effect might occur upon observation. But only when we observe or measure the wave function does it branch or collapse into what we think of as an actual 'thing', a particle or a wave depending on how we observe it. Even more eerily, as some physicists have proved and noted, it is almost as if the quantum wave function 'knew' we were looking at it before we looked at it. And even spookier, upon observing the quantum wave function, entanglement emerges as a phenomenon creating what may be called 'realities' and producing identical behavior among multiple particles in these realities no matter where they are in our space or time or other 'realities'. Entanglement 'becoming' existent from what we observe and what we will understand in this text might correctly be called 'the chaos of the quantum wave function'. More technically, the act of observation collapses or branches the wave function from its hazy, spooky state of all possibilities forcing a probable range of values or measurements in our 'reality' and 'realities' unbeknownst to us. Physicists call this 'state reduction'. When the observer effect creates a 'classical' narrative, ...we take as 'reality'; it is said to 'decohere' the wave function. The decoherence of the *entangled* wave function will have an exact twin or twins perhaps on the other side of the universe or in other 'realities' taking on the same value instantaneously – without time or space. It is as if entangled particles do not even 'see' our universe which Einstein's relativity tells us is limited by the speed of light. Oh, and systems of entangled particles are common. Entangled systems have this really weird property where an observed property of one particle in one entangled system acts as if it was the same exact property in another entangled system without any regard to time and space. In other worlds or realities all probable values of all the observed property are exhausted creating a kind of harmonic symphony whose motif might truly be called 'spooky'?

Ok, you might have thought all that was weird, but it gets much weirder. ‘Seeing’ as the observer effect causes particles or systems to come into ‘existence’. We see the wave function decohere as a value, a reality, might we say as classical history? However, the quantum wave function itself simultaneously, without time, ‘knows nothing of our ‘seeing’, the collapse or branch generated by the observer. The quantum wave function in some spooky way simply already anticipated the impact of what the observer ‘saw’ or measured and simultaneously all other possibilities affected by our observation. It is as if somehow *it* knew all along what was going to happen. The wave function never sees a collapse or branch as we, the observer, imagine. The wave function simply already anticipated the observer’s intervention as ushering in a plethora of new possible values - irrespective of temporality and spatiality.

You can tell I am struggling with words. That is why I wrote this monstrosity of an book and the series volumes to try to make these findings more accessible to folks who do not want to spend years studying mathematics. And if you thought my embellishments here are exaggerated too much, as we will see, all this makes quantum computing, which is currently alive and well, supercharge artificial intelligence as if it were on hyper-steroids. This is called ‘quantum intelligence’. It is important to note that quantum computers are not just "faster" versions of classical ones; they excel at specific mathematical structures (like optimization and simulation). More on that later. This book started as a post but of necessity, it grew.

These ideas have forced me to think about philosophy and Levinas in many new ways. In particular, the sense of entanglement we may have with each other may not be so obvious as our histories pretend. Certainly, love is one example of entanglement. Does that relate to quantum entanglement? I hope the remainder of this “post” will perhaps provoke others to reflect on how little we all know…and how life is so much more wonderful than we ever imagined! The discussion in the latter part of this book answers a gaping question, a void, that any kind of physics could ever possibly

inform us of : Who is the other that faces us and why are we obligated to the other in a fashion history and science have only failed to accomplish? This is not an academic work but rather gives some history and background in areas of physics and philosophy which I think can give a larger perspective of how we got here, who we are facing, and interrupt our monologues that can never satisfy themselves. I have much more detail with many quotes, footnotes, and references to explore all of these areas. Feel free to skip or read as much as you like!

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1 "The Present Situation in Quantum Mechanics: A Translation of Schrödinger's 'Cat Paradox' Paper," trans. John D. Trimmer, Proceedings of the American Philosophical Society 124, no. 5 (1980): 323–38.

"Discussion of Probability Relations Between Separated Systems" (1935)

Introduction

1

Quantum entanglement and human love share a spooky uncertainty: a unison that refuses to collapse into sameness. Entanglement implies a unique relationship; it is not merely transactional, a simple exchange of cause and effect. Rather, it suggests an intimacy that preserves difference—a bond where two distinct entities do not melt into a single identity, nor do they drift into indifference.

In the quantum realm, this relationship implies a mutual reciprocity that blurs the harsh lines between subject and object, observer and observed. There is a hazy middle ground where the binary categories of "Same" and "Different" no longer strictly apply. Perception of entangled quanta falls from indeterminacy—where distance no longer matters—into a probable determinacy, where a beautiful harmonic unison is achieved. This is not achieved by assuming the other is "always the same," but thrives gracefully through dynamic, working perception.

Entanglement cannot be reduced to a singular object or a mystical perception. It derives its beauty from a fragile, pure contingency arising together with the other. In this book, I propose that this physical phenomenon mirrors—or perhaps signifies the erasure of a trace within—a mutually passionate embrace: a responsibility in how we observe, how we see the Other, and how we reciprocally give value and place to them. Entanglement, whether in quanta or in love, fails when it is perceived as a rigid binary—subjective versus objective—or as narcissism, where the "other" is merely my idea of them.

Psychology defines projection as displacing one’s ideas,

emotions, or desires onto another person. When we mistake our internal state for the reality of another person, we do not see the Other; we see only ourselves in a mirror. In the case of projection, the "other" turns out to be a charade—a mannequin dressed in our own history and expectations. Projection imprisons the self in a "no-exit" of its own face, its own narcissism. Throughout this book, I will refer to this form of projection as an Echo. When all we see is our own history in the face of another, we only echo ourselves back to ourselves. Eventually, in the case of love, when all we hear is our own echo, we lose even the possibility for alterity (otherness)—the possibility for true entanglement with the Other.

A crucial distinction must be made here to satisfy the demands of rigorous philosophy. Emmanuel Levinas argued that Ethics is First Philosophy—it precedes ontology (the study of being and physics). If I were to suggest that quantum physics *explains* ethics, I would be committing the very error Levinas fought against: reducing the Other to a system of *natura*l laws.

That being stated, an interesting parallel exists. Just as quantum mechanics reveals the failure of classical physics to totalize nature, Levinas reveals the failure of ontology—the study of being (which includes physics)—and, as we will see, totalizes the other. It would be a grievous mistake to think that "quantum physics proves Levinas is right." Physics cannot "prove" ethics in this framework. But perhaps physics' "spooky action at a distance" might clear a space for something entirely different—making way for a Levinas.

To explore this, I will utilize Levinas's concept of the "Trace" (*La Trace*)—a sign of a past that was never a present, something that passed but was never fully "there" to be grasped. In a move that brings physics and philosophy into dialogue, we will see how a particle in superposition has a spooky way of leaving a mark on a detector without having a definite trajectory—perhaps serving as a potent physical metaphor for Levinas's Trace.

A final note on terminology: In French, Levinas distinguishes between *l'Autre* (the other as a general concept of difference) and

Autrui (the personal Other, the human being facing me). To respect this distinction, I will use the Other (capitalized) when referring to Levinas's singular notion of *Autrui*, and other/otherness (lowercase) when referring to the general other—the other we assume, physical difference, or quantum alterity—all quite different from Levinas's Other (*Autrui*) we face.

For Levinas, the "Face" (*le visage*) is not a body part. It is the vulnerability of the Other before my will, intentions, and desires—it is a nakedness before their existence commanding, "Thou shalt not kill." It is an ethical authority. While we typically think of a face as a physical set of features, the Levinasian Face is that which resists my power in a "passivity beyond all passivities." It is the opposite of the face of Narcissus, which is merely a concept fashioned as my own Echo.

…

Must we then ask of the lover, "What looks back at us in that divine trance of love?" What wisdom can we discern from ancient sources about the lover's gaze?

The myth of Narcissus and Echo comes to us from two primary sources: Conon, a Greek mythographer writing shortly before the 1st Century, and Ovid's *Metamorphoses*, a Roman epic from approximately 8 AD. I will summarize and combine both versions of this myth below:

ALL WE SEE: NARCISSUS

> Narcissus's father was a river god. His mother was a nymph named Liriope. A prophet told his mom that only by Narcissus not recognizing himself could he get old. Narcissus was extremely beautiful. Everyone loved him. But poor Narcissus could never find anyone to love back. Echo was a very beautiful nymph, but she was condemned to only repeating the last words of anyone who spoke to her. One day she saw Narcissus and immediately and passionately fell

in love with him. She followed him everywhere through the woods but could not say a word to him. She could only repeat his last words. Narcissus in desperation tried to call out to her, “Echo”. But Echo could only echo his last word, “Echo”. In despair Echo tried to hold Narcissus. But Narcissus rejected her. Echo ran away to hide in the woods. While she pined for him, she wasted away in the woods. Finally, and forever, she could only hide in the wind, streams, woods, caves, and flowers of the forest. Her body became rocks and stones. Her voice remained in mountain valleys and caves. Because Narcissus denied his love to everyone, the gods deemed he could never have anything he loved. One morning Narcissus was hunting in the woods and bent down to drink some water in a still pool. When he saw his reflection in the water he fell in love with his reflection. He was so enthralled with his reflection that he could not move or peel himself away. He tried to grab the reflection but could not have it. This made him more desperate to hold the reflection he loved. Narcissus could not sleep or eat but only looked at the reflection he loved. He begged the gods to tell him why he was denied the love he and his reflection shared. He resolved that he would not leave the one he loved and that they would die together as one. Insanely in love, Narcissus stayed by the water and wasted away. Echo returned and saw him wasting away. As Narcissus lay dying Echo mourned him and echoed his words. All the other nymphs in the forest covered Narcissus with their hair and gave him a funeral. When they removed their hair and turned to look at Narcissus’ body all they saw was a flower. [2]

The myth of Narcissus will be a recurring theme throughout this book. Levinas writes that “*The ego is in itself like a sound that would resound in its own echo, the node of a wave which is not once again consciousness.*” [3] This will be discussed much more later as this book

progresses.

ORPHEUS' ABYSS

Whether we like it or not, we are facing extreme externalities from physics which strike at the root of philosophy, our histories, our cultures, and even our languages. The only real choice we have is to gaze into this abyss to see what looks back at us or to retreat back into ever darkening shadows of history's cave. To gaze back to the cave is the gaze of Orpheus.

> The Gaze of Orpheus is from the Greek myth of Orpheus and Eurydice. Orpheus was the greatest poet and musician in history. He played the lyre. Orpheus fell in love with a nymph named Eurydice. Hymenaios the prophet married them and at the highest moment of their pure bliss prophesied that happiness had an expiration date. Eurydice was exceptionally beautiful and immediately after the ceremony a god named Aristaeus tried to snatch her. She ran into the woods and while dancing with other nymphs celebrating her marriage she was bitten by a venomous snake and died. Orpheus could not live with the sorrow of his loss, so he went to Tartarian cave [the underworld of the dead, the gateway to Hades] to retrieve his beloved. He played his lyre so beautifully that the bloodless ghosts of Hades wept. The ghosts were so moved they made a onetime exception to let Eurydice leave and return back to the land of the living. Orpheus was told she could leave with one exception, that he does not look back until they returned to the land of the living. When Orpheus was returning from Hades with Eurydice, he believed they were in the land of the living, he turned back to see Eurydice and tragically saw that she was one step away from the land of the living. She was still in the Tartarian cave or Hades and told Orpheus "Farewell" as she

fell back into Hades.

Here is the advice to those who would look back at this moment to ever darkening shadows of history's cave:

To you this tale refers,
Who seek to lead your mind
Into the upper day;
For he who overcome should turn back his gaze
Towards the Tartaric cave,
Whatever excellence he takes with him
He loses when he looks on those below.
—(Boethius, Consolation of Philosophy, III.m12) [4]

The myth of Orpheus will also be a recurring theme throughout this book.

An Important Caution About Radical Differences with Levinas and Quantum Physics

I will discuss this in much more detail later in the book but this book in no wise wants to establish a classical causal relationship between Levinas and quantum physics. I use quantum physics as a preliminary step to indicate that classical physics has a very uneasy relationship to quantum physics. As I will discuss there are some ‘semiclassical’ corollaries quantum physics has with classical physics but the key determinant here is ’semiclassical’. Even though technically this is incorrect, for now it might be best to think of semiclassical in terms of a conceptual bridge, as useful metaphors, analogies, mental constructs that aid understanding but below the surface quantum physics cannot be tamed by classical physics. This will be discussed in much more detail later.

More importantly, at the outset I want to make sure that neither is Levinas’ philosophy to be taken as some sort of crude cause and/

or effect relationship to physics. There is an enormous, unbridgeable gap between quantum physics and the work of Levinas. I use quantum physics as a stepping off point to lose the grip of classicism, both scientific and philosophical, so that we can find a start to Levinas' work. To look back to the Tartarian cave of classicism in understanding Levinas is to miss his thinking altogether.

A WORD ABOUT PHYSICS AND *PHUSIS* - PHYSICS ANCIENT RELATIONSHIP TO PHILOSOPHY

Language is not universal. Language grows, opening up a world that 'makes sense', that gives us an orientation to our world, our culture, our gods or God. We get 'common sense' from language. Language is navigation as disclosing our world, our values, our hopes, desires, expectations that the sun will rise again on a new day for activity. But language has not always been the same in any regard. Language grows, gives, bestows but not universally as if absolute. Absolutism is certainly in our contemporary histories, but it was not always so. We have children, they grow, they learn, they hopefully become adults. We try to help them understand how to navigate 'reality'. But so much is taken for granted – necessarily so I might add. However, when we start studying histories the further we go back, the more we understand that the world was very different. Why? Because language – what provides us with 'understanding' – was different. In this book I want to look at the dawns of language. This is what linguists concern themselves with. Linguists are very specialized and use many tools to understand how people were, how they thought, how they comprehended their day-to-day world. And when we go way back, many linguists understand how language started, its origins – the world it opened up from the dawn of Homo sapiens.

Linguists have put together regional maps of various language groups and dated them. In a nutshell, many linguists find that there

was no single 'origin' to language. There were disparate confluences of languages. This mirrors what historical linguists call the "Wave Model" (Wellentheorie), where languages intersect like ripples from multiple stones thrown into a pond, rather than branching cleanly from a single trunk.

While linguists traditionally reconstruct singular 'proto languages' (ancestors), a deeper look suggests these origins were likely disparate confluences. To be fair this is a debated hypothesis, not a settled fact. The debate is between monogenesis (one single origin, 'Proto-World') and polygenesis (multiple independent origins). What follows is a more detailed explanation of the polygenesis findings.

In my understanding the “Wave Model” has beautiful allusions to what I will discuss in quantum physics, but metaphors only go so far. In any case metaphorically, I do not understand rhizome as a metaphor for a single tree. I understand rhizome more as a mangrove forest or fungal network perhaps even as uncharted worlds of mangrove forests or might I dare – universes of worlds of mangrove forests? Even more, as we will see, “universes” are a crude way of understanding what the prominent many-worlds interpretations in quantum physics are about. It is much more *sublime* than that.

In the farthest beginnings of language, there was never a singular, static 'garden' of linguistic inferences and meanings. There was instead a word I will make up: *chaogenesis* (chaos growing as what we now think of as beginnings, as genesis or origin)—however a wild, non-homogenized diversity of protolanguages did not descend from a single trunk but erupted like rhizomes, eventually connecting every point of experience to every other point without the mechanics of hierarchy, intention, or preordination.

To navigate this tangled root system, I would like to suggest another kind of ground: *rhizo-phusis (*rhizome emergent at one point in the ancient Greek word *phusis)*. This word was transformed as our word ‘physics’. But physics has subterranean roots arising in a

much older Greek word (*phusis* or *physis*). *Phusis'* ancient linguistic root is a cognate from the Proto-Indo-European language family (PIE, 45th to 25th century BCE) in the root *bʰeu- (or bʰuH-) meaning "to grow". In the 8th century BCE we find it has sprouted in a Greek term *phusis (*or *physis)* where Hermes describes magical growth powers of a herb.

Much later the Latin translation/transformation of Greek *physis* into *natura (*nature*)* derived from *nasci* brings in origin as birth, to be born, and further to be signaling intrinsic character away from *rhizo-phusis* and rhizomic growth.

Sprouting spontaneously in the East *chaogenesis* erupts at last as Brahman. Long before Latin intuitions *nature, physics* the Sanskrit *bṛh* blossoms into Brahman (15th to 12th century BCE) also from the Proto-Indo-European (PIE) language family.

The PIE root passes from *PIE bʰerǵʰ- (meaning 'to rise' or 'be elevated') to the Sanskrit root bṛh (shifting to 'swell', 'expand', or 'burst forth'). This marks a transformation from vertical height to volumetric growth—a swelling chaogenesis that becomes Brahman (absolute reality/Divine force). The Vedas (15th–10th centuries BCE) planted these seeds in archaic Sanskrit, which later blossomed in the Upanishads (8th–3rd century BCE). Here again, rhizomatic inferences from 'to swell,' 'to expand,' or 'to burst forth' morph towards an exotic state.

From the Proto-Indo-European language family there are further links to diverse proto-languages:

From Proto-Indo-Aryan (PIA) spanning the 20th to 16th century BCE from the root *bʰŕ̥ź̥ʰma as expansion, swelling, and towards sacred power. This becomes the basis for complex philosophical terms in the Rigveda.

From Proto-Indo-Iranian (PII) from the 25th to the 20th century BCE from the root *bʰŕ̥ǰʰma as 'to rise up', 'ascend', 'to be elevated', 'up high'.

Rhizo-phusis captures the idea that ancient tongues were not trying to navigate a static world - of what is already accounted for,

but swell and grow in entanglements which have not yet found a sun.

Thus, in the rhizo-phusis of the ancient predawn world, we find a startling co-arising where nouns have not dominated yet, equated yet, but verbs growing: ‘reality’ not yet arriving from its deep, dark roots into a collection of things-objects-names. Instead 'swelling’, ‘growing’ —a dynamic, expanding vitality not yet formed as genesis.

Chaogenesis brings rhizo-phusis from the dark subterranean earth to a genesis of the ultimate reality, gods and God, of becoming, of physics, of nature, and classic physics… of a sun that once shone up a barren earth…but underneath chaos, darkness, nurturing, budding, and swelling until sprouts that welcomed the sun and genesis.

It was only later that Latin metaphysics and the taxonomies of the Royal Society sought to manicure this chaogenesis into orderly rows, hollowing out the 'swelling' of Brahman and the 'growth' of phusis until they became artifacts in a museum of terms. To understand the quantum nature of reality—which is itself a swelling probability wave—we must return to this living, rhizomatic root. Rhizo-phusis and chaogenesis are terms that grow and swell throughout this book, intertwined in dark roots that burst forth into histories. Perhaps we may hear an echo of these pre-histories in quantum physics.

The earliest Ionian school of Pre-Socratic philosophy dates back to the sixth century BCE. This school included Thales (c. 624-546 BCE), Anaximander (610-546 BCE), Anaximenes (585-524 BCE), Heraclitus (c. 540-480 BCE), Anaxagoras (c. 500-428 BCE), and Archelaus (5th century BCE). [5] In Martin Heidegger’s (1889–1976) “Introduction to Metaphysics” he writes,

> Now, what does the word phusis say? It says what emerges from itself (for example the emergence, the blossoming, of a rose), the unfolding that opens itself up, the coming-into-

> appearance in such unfolding, and holding itself and persisting in appearance — in short, the emerging-abiding sway. [6]

Before we had the Western reduction of *phusis* to physics and the subsequent Latin reduction to '*natura*' or nature, *phusis* was an idea which encompassed both nature (physics) and 'before nature' (metaphysics). *Phusis* was not reduced to a mere contrary or negation of one for the other. As such, there was an excess which has long been lost to histories, languages, and cultures.

> In the age of the first and definitive unfolding of Western philosophy among the Greeks, when questioning about beings as such and as a whole received its true inception, beings were called phusis. The fundamental Greek word for what is usually translated as 'nature.' We use the Latin translation natura, which really means 'to be born,' 'birth.' But with this Latin translation, the original content of the Greek word phusis is already thrust aside, the authentic philosophical naming power of the Greek word is destroyed. [7]

Wisdom is the recovery of that excess which has been lost. Wisdom is also the lived, embodied, opportunity to face beauty, wonder, and mystery which culminates as growth - promise for the future. Growth does not age but renews itself. The moment of opportunity we call growth is ever new, rich, overflowing – infinite.

BEYOND OUR FACE

First, a few very general statements about the scope of this document; later I will go into more detail. This book deals with concepts that are not very intuitive to the modern mind – 'non-causality'. Ironically, when people talk about conventional ideas of

God or gods or religion, whether we believe or not, we all have a keen sense of what is meant by such talk. Certainly, the very notion of god-like beings has been echoed through history accompanied by much violence and catastrophes. The assumed clarity of what a god-like being would consist of in the West comes from a long history, tradition, and culture which philosophy calls metaphysics. I want to make a point about the word ‘metaphysics’. Our modern notions of metaphysics originated from Latin centuries after Aristotle. However, the term *Metaphysics* (*ta meta ta physika*) is Greek in origin. While it was famously popularized and interpreted through the Latin tradition, the "origination" (the coining of the title) is attributed to Greek editors of Aristotle, likely Andronicus of Rhodes, in the 1st century BC.

The Latin metaphysics of origin was the signet of rule and violence through subsequent histories. One example of this was Constantine the Great.

Constantine the Great, born in the later 280s, was the first Roman emperor to profess Christianity. Constantine enacted many administrative, financial, social, and military reforms to strengthen the empire. He viewed Christianity as the most appropriate religion fitting with the imperial cult. Constantine used Christianity as a political tool to gain unanimous approval and submission to his authority from all classes. He also tried to establish conformity between the different forms of contemporary Christian belief, notably calling a council of bishops to the eastern city of Nicaea. [8] Constantine the Great is known for his military reforms, such as the creation of the ‘Comitatenses’, a mobile unit of the Roman army that served on campaigns against external enemies or Roman rebels. He was a successful military commander and won several battles against his rivals, including Maxentius and Licinius. Maxentius was a Roman emperor who reigned from 306 until his death in 312. Licinius was a Roman emperor who ruled from 308 to 324. He married Constantine’s half-sister Constantia in 313. [9]

> The word ‘metaphysics’ is notoriously hard to define. Twentieth-century coinages like ‘meta-language’ and ‘metaphilosophy’ encourage the impression that metaphysics is a study that somehow “goes beyond” physics, a study devoted to matters that transcend the mundane concerns of Newton and Einstein and Heisenberg. This impression is mistaken. The word ‘metaphysics’ is derived from a collective title of the fourteen books by Aristotle that we currently think of as making up “Aristotle’s Metaphysics.” Aristotle himself did not know the word. (He had four names for the branch of philosophy that is the subject-matter of Metaphysics: ‘first philosophy’, ‘first science’, ‘wisdom’, and ‘theology’.) At least one hundred years after Aristotle’s death, an editor of his works (in all probability, Andronicus of Rhodes) entitled those fourteen books “Ta meta ta phusika”—”the after the physicals” or “the ones after the physical ones”—, the “physical ones” being the books contained in what we now call Aristotle’s Physics. The title was probably meant to warn students of Aristotle’s philosophy that they should attempt Metaphysics only after they had mastered “the physical ones,” the books about nature or the natural world—that is to say, about change, for change is the defining feature of the natural world. [10]

Prior to the Latin transformation of ‘metaphysics’ from ancient Greece, Aristotle’s works were very differently understood from what the word ‘metaphysics’ would have us believe. Aristotle’s Greek writings that later became known as Metaphysics were referred to as the writings after the Physics by Andronicus of Rhodes in the first century BC. The term “metaphysics” itself was not used by Aristotle but was coined by later Latin scholars. The work is a compilation of various texts treating abstract subjects, notably substance theory, different kinds of causation, form and matter, the existence of mathematical objects and the cosmos,

which together constitute much of the branch of philosophy we now know as metaphysics. The works themselves are divided into fourteen books, which are usually named after the first thirteen letters of the Greek alphabet. The books, in order, are Alpha, Alpha the Lesser, Beta, Gamma, Delta, Epsilon, Zeta, Eta, Theta, Iota, Kappa, Lambda, Mu, and Nu. [11]

The history of metaphysics is a history of violence, rule, and authority. But so was science in its not so glorious beginnings. Even well into the beginnings of modern philosophy with Descartes in the 16th century, much of science was authenticated by articles of faith. In this ancient sense, metaphysics gives us an assumed familiarity, an idea pro or con, of what such a supra-natural being as a god would consist of, of what it would be. However, when you really think about the idea of a God, it is not so clear. Common notions are that God is omnipresent (present everywhere), omniscient (all knowing), omnipotent (all powerful), and God caused existence but is uncaused. We really have no critical understanding of what 'God' means and how such a being could be. But religious people tell us to just 'take it on faith'. In practice, this generally means just accept it as true and act as if it is true. Unfortunately, this tends to be an excuse for not really thinking about what the idea of 'God' means.

If such a being were 'real' meaning showing itself in the same way we think about physics for example, there should be an amazing kind of astoundment, wonder, and awe which should be a constant source of reflection, thought and passion. Unfortunately, many folks who believe seem to me to be either ho-hum about it, or fanatical about it with fairly vague ideas of what it would mean. The notion of fanatical is not at all what I am referring to when I think of astoundment, wonder, and awe. Fanaticism is about power over someone else. It is about convincing and can even spill over into violence. Beauty as astoundment, wonder, and awe is first and foremost self-fulfilling. It is about appreciation and reflection not having or getting control.

I am not trying to debate ideas of philosophy, theism, atheism, or agnosticism. I hope to awaken something which should strike you as very odd, otherworldly, not easily relatable but something rather truly mind-blowing and quite different from any of the usual things occupying our minds and reducing our imaginations. If you really get it, you may find that you will feel regularly amazed and think “How can this be”? The topic of this book is something one of the smartest minds in history said spooks him. Einstein called entanglement “spooky-action-at-a-distance”. It is important to note that while the *effect* is instantaneous, no classical information can be sent faster than light (the No-Communication Theorem to be discussed later). It certainly is that, but it is more. It is something that, if we get it, will continually call upon us to reevaluate our most basic notions of reality - cause and effect, time, and space. Additionally, certain philosophical topics in the 20th century have broken through classical roots of rationalism, modernity (as the offspring of classicism), and mechanism. These topics ask us to look more closely at our lived reality, our concrete experiences of life and our relations with each other.

In everyday life, we operate on the principle that we know what reality is and all that implies. Certainly, that is necessary to some extent. However, the topic of this book should regularly cause us to ‘bracket’ [Greek *epoché*, to be discussed later] that bedrock assumption. This should not make us crazy but rather inform us that there is so much we do not know. There is a huge freedom in not knowing. We can be open and active about not knowing. Alternatively, we act as if we know it all. I think this brings us down a path to a hum-drum life, complete with petty gamesmanship, transactionalism ultimately becoming a negative, unhappy person facing our inability to transform into fantasies of who we think we are, or ideals proposed by advertising and social media. Nietzsche called modernity’s current mediocrity ‘the last man’. Now both physics and philosophy in their own unique way have brought us face to face with a radical otherness if only we

have the desire to gaze upon it. First, I will examine how radical externality arises from current physics and later, how philosophy has brought us to yet another radical externality which faces us. The avenues opened by quantum physics, starting in the early 20th century and later ushered in the philosophy of Emmanuel Levinas (1905-1995), have an enormous impact on how we think about and interact with the other and even intimacy, the he or she which faces us.

The inquiries of Einstein in the early 20th century were made possible by new ways of understanding philosophy and physics. These new ways of understanding had their intuitive roots much earlier in philosophy and physics. Sprouting as ancient seeds, these ideas in physics and philosophy emerged and grew intermingled in a complementary fashion amazingly budding in the 20th century into philosophical phenomenology and the science of Einstein's relativity and quantum physics. This was accomplished through massive philosophical and scientific transformations from the ancient Greeks to Latin Christianity to Enlightenment and Modernity.

Over time, metaphysics appeared to fill a needed gap with what empirical science was telling us. Eventually Scholasticism and metaphysics lost its appeal in religious dogma and modernism, starting in the late 1800s, found a way to subsist in commonsense as the thinking machine of materialism. The preponderance of radical exteriorities exhibited in recent physics and compatible intuitions of great philosophers have led us away from classicism and commonly held notions of metaphysics. Both physics and philosophy are finding common ground once again to lead us towards unique new ways of orienting us to 'reality'. These new ways are not just the domain of science anymore but affect us even in the faces of those we look towards. Over time, we have eroded and lost what erupted from what once were chaotic externalities pressed upon ancient inquiries. Now, for the first time, we are faced with an abyssal responsibility whose time can no longer be denied.

Since Aristotle metaphysics has had a rather incestuous relationship to science. Even in metaphysics' nocturnal internment in empirical materialism. At times it exhibited metaphysical behavior in seeking continuity with previous scientific theories at the expense of observation. For example, empiricism rests on metaphysical ideas assuming the idea of 'matter'. It also assumes that observation cannot affect what is being observed. Even after quantum mechanics physicists still have a hard time absolving themselves from these archaic notions of metaphysics. Science still seeks Aristotle's metaphysics as 'first principles', as origin, and causal relationships. Publishing in science can be treacherous as it is swift to condemn heretics which sometimes may actually be ahead of conservatism in science. This happened at the advent of relativity and quantum physics. Underneath all these layers of metaphysics and conservatism working paradigms still value origin, rule, and authority. Perhaps we may find a wisdom, what theology aspired towards but failed in radical alterity, in the quanta of *phusis* and the other. I will discuss this more a little later. *Phusis* is a very ancient Greek word with ties to languages all over the ancient world as a cognate of the verb 'to grow'. Later in ancient Greece, *physis* was translated into Latin as *natura* or nature. [12]

TOWARDS THE ABYSS

Schrödinger wrote "*I would not call [entanglement] one but rather* ***the*** *characteristic trait of quantum mechanics, the one that enforces its entire departure from classical lines of thought.*" [13] Entanglement comes before spacetime, cause and effect, phenomena as classic physics thinks it. The ramifications of this on our commonsense experience of reality are truly mind boggling! The 20th century proved beyond any reasonable doubt that quantum entanglement is real. Not only that, but it is 'spooky' and not local (more on that later). I want to bring out some amazing studies in physics and relate them to broader philosophical issues which can never be

proven in any classical sense as ‘absolute’ but nevertheless abolish any historical interpretation which cannot allow an other to itself. I hope we will find that what looms before us in quantum physics is an awkwardness in even being able to find an easy pathway to understanding, which may nevertheless have value as a residue for the reader to take notice.

In the years from 1925 through 1927 the newly discovered awkwardness of findings in quantum physics prompted a collection of views mainly attributed to Niels Bohr and Werner Heisenberg to try to find terms which made their findings more palatable for public consumption and for themselves. Some interpretations of the Copenhagen interpretation of quantum physics (to be discussed in more detail later) wanted to downplay any philosophical speculations about the consequences of quantum mechanics. I think of the Copenhagen interpretations as more of a struggle than a doxa about the new findings of quantum physics. The reason for this is that there were a number of especially important physicists in the 20th century, including Bohr and Heisenberg, who in more or less publicly accessible findings did not shy away from writing about the far-reaching ramifications of quantum physics. This included Einstein who struggled over the ending decades of his life to find an alternative and Schrödinger as well who was more willing to come to terms with these highly odd findings.

There is a yawning gap between classical physics and quantum physics in how the classical world understood reality. This gap is not in the ‘idea’ of uncertainty itself. Classical physics understood uncertainty very well and created much of the math which is still used in quantum physics. One clear example of uncertainty in classical physics is how it manages massive systems like the weather for example. The issue with predicting weather is not so much math or the computer models but with the complexity of initial information in the starting conditions for what comes later. Probability was well understood in classical physics and was based on the solid math of calculus and derivatives. Probability depended

on the accuracy of stochastic data effectively meaning the less randomness in the initial data, the better the results. In classical science uncertainty is the practicality of a complexity in absolute time and space. However, in classical physics 'reality' itself is not uncertain. In quantum physics 'reality itself' must be uncertain countering the certainty of classicism in science and philosophy. This is the yawning gap.

The yawning gap is in the classical idea of space and time as absolute *itself* and this idea cannot be distanced from the notions of classicism which necessarily shaped our notions of reality, common sense, and practicality. Uncertainty for classic mechanics was a stand-in for lack of information about absolute time and space. Uncertainty for quantum mechanics tells us there is no absolute time and space – there is no certainty that will one day surface when we know more. It tells us that there is a yawning gap between classic mechanics and quantum mechanics. It clearly shows us that our commonsense notions of 'reality' are a result of our history and nothing else. Our parochial notions of 'reality' and 'existence' cannot be a foundation or even have any relation to what is meant by quantum uncertainty. Rather than try to fall back from this awkwardness, this impasse, this yawning gap as Orpheus' gaze, let's see if we can let it develop in the context of contemporaneous physics.

More specifically for this part of the book, the yawning gap shows up in the current abyss between the very large and the very small or more properly gravity and the other three fundamental forces of electromagnetism, the weak nuclear force, and the strong nuclear force to be discussed later. Even Einstein's special theory of relativity published in 1905 and his general theory of relativity published in 1915 beautifully lay the groundwork and anticipate the abyss between quantum physics and spacetime. It took decades to emphatically show the necessary 'reality shattering effects' of Einstein's discoveries. The aftermath of the seemingly unrecoverable split between quantum mechanics and spacetime has

shaken not only the foundations of classical physics but concurrently shattered historic philosophical traditions which had worked their way into common social perceptions of ‘reality’.

Leonard Susskind (1940 - Present) is a renowned theoretical physicist at the Stanford Institute for Theoretical Physics, which is one of the most prestigious research facilities in high energy and condensed matter physics in the world. He has stated in the videos referenced at the end of this document that he sees a real and exciting synergy in quantum gravity (more on quantum gravity later too) which he believes is an indication of a major paradigm shift in the history of science. Concurrently with Einstein, the 20th century brought on philosophical phenomenology which had parallel lines of inquiry vastly revealing the conditions wherein notions such as ‘reality’ find their underpinnings. I see a complementary and somewhat symbiotic relationship to the enormous changes to both physics and philosophy in the 20th century. The gaze of Einstein to de-spooky his own findings of quantum entanglement in local variables (to be discussed later) finds its recurrence in the ancient gaze of Orpheus’ Eurydice which can never be the same, transporting us to a never-recurrence of the same, the never-certainty of love and the nether-love of certainty.

THE GAZE OF EINSTEIN

Einstein noticed an odd behavior with two particles. In his early 20th century discoveries of relativity, Einstein noticed that without any interaction between two particles, a measurement of one property of a particle would give information of the other particle without even measuring the second particle. Years later Schrödinger described this phenomenon as "entangled". Einstein correctly said that at a specific time symbolized as t_2, a measurement of one particle's position would instantly establish the position of the other particle - without measuring it explicitly. No interaction with the second particle is involved. Schrödinger described the two particles

as "entangled" (*verschränkt*) at their first measurement, so the EPR [Einstein, Podolsky, and Rosen] paper published in 1935 documented "nonlocal" phenomena which are now known as "quantum entanglement."[14]

Einstein's 1935 Papers

In 1935, Einstein and others published two mind blowing papers. He was fighting two different battles (one against probability, one for geometry) in the same year.[15] One paper is about spacetime being folded into parallel sheets with a bridge between the sheets. Later this was thought in terms of two blackholes joined by an Einstein-Rosen (ER) bridge or wormhole. It was a journal article entitled, “The particle problem in the general theory of relativity”.[16]

> Rosen moved on to Princeton for post-graduate study, where he encountered Albert Einstein at the Institute for Advanced Study; they must have hit it off, for Rosen became Einstein's "clerk" for two years. Together, they wrote and published a paper that is responsible for whatever fame Rosen has in the world outside quantum mechanics. The paper was titled "The particle problem in the general theory of relativity" and appeared in Physical Review in 1935. In the paper, Einstein and Rosen discussed the possibility that space-time might be folded into parallel sheets, with a particle acting as a "bridge" between the sheets. The proposed connection would later be called an Einstein-Rosen bridge, and even later, a wormhole.[17]

The other paper is on quantum entanglement and asked the question of the necessity of uncertainty in quantum mechanics. The Einstein, Podolsky, Rosen (EPR) paper was entitled, “Can Quantum Mechanical Description of Physical Reality Be Considered Complete?”[18] Einstein was an important contributor to our

understanding of quantum mechanics. Einstein referred to quantum mechanics and quantum entanglement as “spooky-action-at-a-distance”. In his 1935 paper he tried to show that quantum physics was not complete due to quantum entanglement and its seeming non-local spookiness. This started three decades where Einstein tried and ultimately failed to show a local explanation for this ghost. Locality for Einstein was based on hidden variables in local spacetime which would account for the ghastly way in which quantum entanglement seemed to defy the absolute speed limit of light. If locality was proven true, then it would have been able to fit hand and glove with relativity. This would have unified the very large and the very small. During the decades after Einstein’s death, locality was proven to be impossible in explaining quantum entanglement.

I will discuss these papers more and their incredible historic consequences. But for now, it turns out that decades later both papers prophetically envisioned the link between gravity vis-à-vis blackholes (the ER paper) and quantum physics vis-à-vis quantum entanglement (the EPR paper). This link is what we now call a wormhole.

> The story of the holographic wormhole traces back to two seemingly unrelated papers published in 1935: one by Einstein and Rosen, known as ER, the other by the two of them and Boris Podolsky, known as EPR. [19]

This link called a wormhole has been given the honorary formula,

$$\text{ER} = \text{EPR}$$ [20]

> ER = EPR is a conjecture in physics stating that two entangled particles (a so-called Einstein–Podolsky–Rosen or EPR pair) are connected by a wormhole (or Einstein–Rosen

bridge) and is thought by some to be a basis for unifying general relativity and quantum mechanics into a theory of everything. [21]

This link between gravity and quanta prefigured decades of later work which has now become known as quantum gravity. I will discuss these topics much more later. Einstein's discoveries were not commonly accepted as they are now.

Initially, in the 20th century, the findings of Einstein's relativity were highly decried as demonic and blasphemy, because it fundamentally cut the foundation out of an absolute God and his corresponding moral absolutes. Can we say Einstein 'woke' some of us up? Relativity revealed a much higher level of predictive accuracy for astronomy than classic physics. It showed that spacetime could be conceived as four curved dimensions, where gravity dominated the geometry of cosmic, dimensional fabric. Gravity is created by mass or energy on the canvas of curved spacetime. Einstein's most famous formula, $e = mc^2$, shows that energy (e) is equal to mass times the speed of light squared. The speed of light is 186,000 miles per second. Einstein's formula tells us anything with mass is composed of energy and vice versa. There are two forms of energy which act externally on an entity, kinetic and potential energy. Kinetic energy is the energy a body has because of its movement. Potential energy is the energy a body has because of its position or state.[22] Here are a few more topics which will be discussed in more detail later.

In physics, there are also four fundamental forces in the universe - gravity, electromagnetism, and the strong and weak forces. The photon is a massless wave/particle, wavicle, which travels at the speed of light in a vacuum. The photon is responsible for electromagnetism.

A photon is the carrier of the electromagnetic force and is the quantum form of all electromagnetic radiation. This

includes, light, radio waves, microwaves, X-rays, gamma rays and more. The most common to humans is visible light, which we detect with the retinas in our eyes.[23]

ON ORIGIN

Cosmology tells us that all the forces we know now were one force within 10^{-43} seconds after the Big Bang and in that time period gravity emerged first leaving the unified force of the other three forces. But in the Theogony Hesiod around 730 BC asks the Muses the question, what god came first? [24]

> [104] Hail, children of Zeus! Grant lovely song and celebrate the holy race of the deathless gods who are for ever, those that were born of Earth and starry Heaven and gloomy Night and them that briny Sea did rear. Tell how at the first gods and earth came to be, and rivers, and the boundless sea with its raging swell, and the gleaming stars, and the wide heaven above, and the gods who were born of them, givers of good things, and how they divided their wealth, and how they shared their honours amongst them, and also how at the first they took many-folded Olympus. **These things declare to me from the beginning [ἀρχῆς, archê], ye Muses who dwell in the house of Olympus, and tell me which of them first came to be [γένετ', genet'].** [25]

The muses naturally reply with a muse,

> [116] **Verily at the first Chaos came to be [γένετ', genet']**, but next wide-bosomed Earth, the ever-sure foundations of all the deathless ones who hold the peaks of snowy Olympus, and dim Tartarus in the depth of the wide-pathed Earth, and Eros (Love), fairest among the deathless gods, who unnerves the limbs and overcomes the mind and

> wise counsels of all gods and all men within them. From Chaos came forth Erebus and black Night; but of Night were born Aether and Day, whom she conceived and bare from union in love with Erebus. And Earth first bare starry Heaven, equal to herself, to cover her on every side, and to be an ever-sure abiding-place for the blessed gods. And she brought forth long Hills, graceful haunts of the goddess-Nymphs who dwell amongst the glens of the hills. She bare also the fruitless deep with his raging swell, Pontus, without sweet union of love. [26]

Here is another translation of the area of the text I want to emphasize,

> Tell me all of this, you Muses who have your homes on Olympus, from the beginning [archê, ἀρχῆς], tell who first of them (the gods) came-to-be [γένετ', genet']. [27]
>
> First of all Chaos came-to-be [γένετ', genet']; but then afterwards… (Hyland, et al., 2006) [28]

Let's take a closer look at the Greek words I indicated in the text. **Archê** from ἄρχω (*árkhō*, "to begin, to be first in order") + -η (*-ē*, verbal noun suffix). [29]

Genesis [γένετ', genet'] Borrowed from Latin genesis ("generation, nativity"), from Ancient Greek γένεσις (*génesis*, "origin, source, beginning"). Related to Ancient Greek γίγνομαι (*gignomai*, "to be produced, become, be"). [30] Via Latin, from Ancient Greek γένεσις (*génesis*), from -gen + -ese + -is (Hellenic suffix, present in English but not productive). The simplex genesis as a common noun (as opposed to Genesis, the name of the biblical book) from the late 16th century. As an English suffix from the mid-17th century (attested in epigenesis and palingenesis). Influenced by French -génésie and German -genese and productive in scientific vocabulary from the

19th century. [31] The word genetic is also derived from this root.

Chaos is the translation of the Greek word χάος. In Greek it means a gap, yawn, breach, separation, or void. Wikipedia states, Greek *kháos* (χάος) means 'emptiness, vast void, chasm, abyss', related to the verbs *kháskō* (χάσκω) and *khaínō* (χαίνω) 'gape, be wide open', from Proto-Indo-European *ǵʰ*eh₂n-*, cognate to Old English *geanian*, 'to gape', whence English yawn. It may also mean space, the expanse of air, the nether abyss or infinite darkness. Pherecydes of Syros (fl. 6th century BC) interprets *chaos* as water, like something formless that can be differentiated. [32]

The Greek creation myth tells us at the very beginning [archē], before the gods came-to-be [genet'] there was chaos [χάος], the yawning gap. *Phusis* starts out early on in Greek civilization as intuitions of an excess which cannot be bridged, an abyssal exterior to the drama of the gods and the cosmos. Later in the West, *phusis* grows into a gaping void between physics and philosophy. And now at the advent of twentieth century physics and philosophy, we have once again, for the first time, found our way back to this chasm which cannot be bridged by classicism, a radical exteriority which brings both physics and philosophy inevitably back together again as the intuition of an abyss, of *phusis,* what the Greeks termed 'chaos', to the advent of the quantum wave function.

GENERAL REMARKS

In the 20th century, physics and philosophy departed irretrievably from millennia of historic science and philosophy. This is not an understatement. Our language and history had evolved over previous millennia setting these conditions. Humans have an amazing ability to condense incredible amounts of history into functional language setting the cultural and sociological stage for our practical lives. But the downside of how 'reality' evolves is that societies and countries have a pattern of breaking down resulting in

violence, war, devastation, and human suffering. Historically, scarcity of resources was the source of many of these problems. However, modern science and technology offer us the opportunity to end suffering and war. Unfortunately, we have been unable to end war and human suffering, but rather accelerated our pace towards an apocalyptic nightmare. We have increased the drive towards species extinction with environmental catastrophe and nuclear weapons. Could it be that we may discover reasons for this in the most mundane activities of our daily lives?

How we arrange our lives, our lived environment, is conditioned by our commonsense world. Commonsense does not simply fall out of nothingness. Our history and language created the stage upon which we 'live and move and have our being'. If we are to find a reason for why we cannot solve our global crises, we will need to reflect on this stage which has already been set for us. Language and history are facing a crisis of historic proportions. These easily accessible ways of operating and functioning are losing their meaningfulness. This is not due to some political or cultural 'once upon a time' that we lost due to human frailty. This is coming from a shattering of history and language dramatically affecting basic meaning-bestowing practical values we have. The knee-jerk reaction is to keep doubling down on what 'worked in the past'. When meaning has been lost, fanaticism will not replace it. The past fails when history meets crisis from which practical language cannot account for, make sense of, increasing meaninglessness. We must understand history to understand common sense.

In the 20th century, we functionally assume we understand simple ideas like '*real*', '*true*', even small words like '*is*'. But these simple notions have lost their footing in truly earth-shattering discoveries in physics which have immense philosophical implications. This is not to imply that the negative of these ideas are true. Oddly, changes in philosophy unfolded concurrently with discoveries in quantum physics and science almost as if some intuitive ghost of a new age had emerged in tandem ; -). For

example, relative to biological evolution, histories filtering down into our practical language occur rather quickly. In the past we thought biological evolution occurred over vast time periods. However, we are finding that biological evolution can happen not only slowly over time but also rather quickly in adaptive spurts. There is current research which indicates quantum physics has more to do with biology than we thought. This book will get into much more detail about how quantum physics is affecting all the sciences including biology and evolution but for now here are some relatively recent findings in evolutionary science I will bring up.

There are gaps in the fossil record which naturally cause us to think that we simply have not found the paleoanthropological evidence of intermediate species to fill the gaps. But there is mounting evidence that adaptation may not simply be on the slow track. The pace of evolution has been a topic of debate and research in evolutionary biology. Some scientists argue that species diverge gradually over time. In this view, evolutionary change occurs at a steady pace. If evolution is slow and steady, we would expect to see a complete transition from ancestor to descendant displayed as transitional forms in the fossil record over a long period of time. For instance, consider the evolution of whales from land-dwelling mammals. The preservation of many transitional forms provides evidence for gradual change. It is true that sometimes irregular fossil preservation can create the appearance of rapid jumps even if evolution occurred gradually. Transitional forms are crucial to prove this scenario. Perhaps we might think about this as assumptions in classic science which also understood changes in terms of cause and effect. As we will see, cause and effect itself may be a limited case of something in quantum physics which defies that assumption.

A relatively recent hypothesis is that evolution also happens in rapid bursts during speciation events. This theory is known as punctuated equilibrium. According to this view, evolutionary change is characterized by short periods of rapid evolution followed

by longer periods of stasis where no significant change occurs. In the fossil record, we might observe big changes happening quickly, with few transitional forms between ancestors and descendants. While evolution is often perceived as a slow process occurring over many generations, faster environmental changes (such as climate change, habitat destruction, and pollution) can drive rapid adaptations. These adaptations may occur more swiftly due to selective pressures such as catastrophic events acting on populations. Both gradual change and rapid bursts of evolution are observed in the fossil record. Scientists continue to investigate which pace is more typical and how different forms of evolutionary change occur. [33] It is believed that quantum effects may have an impact in areas like consciousness, neurology, epigenetics (how a gene gets expressed), and other sciences which will be discussed in more detail later. Much of this research is in the early stages. For now, here is a quote from a recent study on epigenetics released in September of 2023,

> In summary, we think there is sufficient evidence for postulating a quantum physics layer of epigenetics, which we propose to name “Quantum Epigenetics". Our hypothesis on this layer's existence, along with some features, is built on theoretical and experimental data from many groups. Remarkably, whereas physics principles in DNA have been extensively explored until the early years of this millennium, research on quantum effects in cellular DNA seems thereafter to have mainly focused on mutational mechanisms. It seems intuitive to us that the more volatile epigenetic landscape is much more susceptible to the transient and partly stochastic quantum effects. These, in turn, might be susceptible to induction or influence by external stimuli, as proposed for irradiation [58]. The principles outlined herein offer, on one hand, the opportunity to further understand how information in DNA is bringing the phenotype (including diseases) into

being and how this can be influenced by external factors. [34]

Phusis is an ancient term which eventually became our word ‘physics’. *Phusis* represents the dynamic, ever-changing chaos of rivers which cannot be stepped into twice. *Phusis* emphasizes the process of becoming, transformation, and the interconnectedness of all things. *Phusis* was eventually translated into Latin as *natura* or nature. The word *physis* is derived from the Greek verb *phyesthai/ phynai*, which means “to grow,” “to develop,” or “to become.” *Physis* is where we get our word physics. [35]

> Physis (/ˈfaɪsɪs/; Ancient Greek: φύσις [pʰýsis]; pl. physeis, φύσεις) is a Greek philosophical, theological, and scientific term, usually translated into English—according to its Latin translation "natura"—as "nature". The term originated in ancient Greek philosophy, and was later used in Christian theology and Western philosophy. In pre-Socratic usage, physis was contrasted with νόμος, nomos, "law, human convention". Another opposition, particularly well-known from the works of Aristotle, is that of physis and techne – in this case, what is produced and what is artificial are distinguished from beings that arise spontaneously from their own essence, as do agents such as humans. Further, since Aristotle the physical (the subject matter of physics, properly τὰ φυσικά "natural things") has been juxtaposed to the metaphysical. [36]

Phusis goes back to the earliest Greek philosophers like Heraclitus (6th century BC). But it has links much earlier than that in much pre-Greek older civilizations all around the world. This will be discussed in more detail later but for now let’s define *phusis* to mean ‘growth’. What did Heraclitus mean by ‘growth’? Heraclitus famously asserted that “everything flows” or “*panta rhei*” in Greek. He believed that change was fundamental to existence. Just as a

river is never the same from moment to moment, the cosmos and everything within it are in perpetual motion and transformation. This principle of change profoundly influenced Heraclitus's ethical views. He saw moderation, balance, and justice as essential qualities that align with the dynamic nature of the universe. Heraclitus associated the element of fire with change and transformation. For Heraclitus, fire symbolized the ever-shifting nature of reality consuming and renewing, representing the cosmic process of creation and destruction. His emphasis on fire underscores the idea that life and existence are not static but constantly evolving. Heraclitus connected *phusis* (which much later in Latin became 'nature') with *ethos* (character). For him, human behavior was intricately linked to what we think now as 'natural order'. His ethical framework emphasized moderation (*sophrosyne*), balance, and justice. These virtues aligned with the cosmic motion he observed. Heraclitus believed that living in harmony with the natural flow of things led to contentment, wisdom, and sound judgment. The concept of *logos* played a crucial role in Heraclitus's philosophy. While it can mean "word" or "reason," he used it to represent an underlying principle that connects *phusis* and *ethos*. But even *logos* has far-reaching meanings to be explored later such as what bridges the *gap* (the yawning gap of Hesiod we call chaos) between the physical world and human conduct. It signifies the cosmic order that governs both. [37]

Phusis in ancient intuition first makes possible the latter history of physics and philosophy. In this case, *phusis* was not yet differentiated in the way we think of physics. But *phusis* contained the intuitive kernels of the 20th century's astounding and quite remarkable findings in quantum physics and postmodern philosophies. Many subsequent histories after these ancient histories lost, differentiated, reduced these ancient intuitions along disparate paths. Examining how languages change and capture histories shows us something about how our practical world gets framed. And this will be a thread I will follow throughout this book to

illustrate extreme differences from histories following *phusis* to what the 20th century has brought before us. In particular, for now let's look at the histories of the words 'physics' and 'science'.

The etymology of the words 'science' and 'physics' reveals directions of historic thought. We must understand history to understand language used in 'common sense'. Common sense did not fall out of the sky. It is simply a reduction of immense historic ages of languages which became snapshots of their thinking and assumptions. The term "science" has a rich etymological history. Originating in the mid-14th century from the Old French "science", means "knowledge, learning, application; corpus of human knowledge". This, in turn, was derived from even older Latin "*scientia*", meaning "knowledge, a knowing; expertness". The Latin term comes from "*sciens*", the present participle of "*scire*", which means "to know". The original notion in the Latin verb probably is "to separate one thing from another, to distinguish," or else "to incise." This is related to "*scindere*" which means "to cut, divide". Already from this we can see that science is splitting from ancient intuitions. This root is also found in Greek "*skhizein*" which means "to split, rend, cleave," and in Old English "*sceadan*" which means "to divide, separate". Over time, the meaning of "science" has evolved. From the late 14th century, it was used to refer to "book-learning," a particular branch of knowledge or learning, and a skill resulting from training. By the 17th-18th centuries, it was once again commonly used to refer to philosophy. But this was a very different kind of philosophy from the ancients. The modern sense of "body of regular or methodical observations or propositions concerning a particular subject or speculation" is attested by 1725. The predominant modern use, "natural and physical science," generally restricted to study of the phenomena of the material universe and its laws by mid-19th century. [38]

Phusis and *physis* are closely related terms in ancient Greek philosophy, but they have distinct nuances. In ancient philosophy, *physis* refers to both the growth and emergence expressed in the

verb *phyesthai/phynai* and later we also see the idea of origin spring towards development. Linguistically, *physis* shares its root with the English 'be' and the German 'bin', though it is distinct from the Latin 'esse'." Being and essence are introduced partially from *physis* much later in history. However, there has been criticism of the conventional translation of *physis* as "nature," especially when compared to the Latin term *natura* (which goes back to the verb "*nasci*," meaning "to be born," having to do with origin). The translation transfers the concept of emerging growth into the realm of being born or origin. In pre-Socratic philosophy, beginning long before with Heraclitus, *physis* is used in the sense of "natural development." Later it refers to origin, the process, or the end result of a 'natural' process. By the 6th century BC, the word could also encompass "all things," somewhat akin to the concept of the "Universe" or "Nature" itself. *Physis* was often contrasted with νόμος (*nomos*), meaning "law" or "human convention." Even near the end of the ancient Greek civilization, another well-known contrast, particularly emphasized by Aristotle, is that of *physis* and *techne*: Here *physis* refers to beings that arise spontaneously from their own essence (e.g., natural growth). *Techne* pertains to what is produced and artificial (e.g., human-made creations).

The book will explore the extent to which quantum physics has impacted not only physics but increasingly all the sciences. I will also explore how dramatically philosophy has been impacted as well. The disruption of quantum physics marks the end of modernism. Modernism finds its early beginnings all the way back to Descartes in the 17th century. The changes brought on by quantum physics and philosophy in the 20th century were more of a simultaneous symbiotic disruption in which both arrived together, feeding off each other and dramatically changing our world-scape. A good way to think of the gravity of these changes is to visualize a gaping void which has no other side. More importantly, common sense has been and will be more and more eroded by this tsunami. As I will get into, this has resulted in fanaticism and reactionary

politics which threaten the very survival of *Homo sapiens*. We will need to discover a more novel commonsense. What I hope to accomplish in this book is a way forward that requires vastly different approaches to how we think of 'reality', 'existence', 'essence', etc. in our daily lives. All of these grand notions are encapsulated in our simple and oblivious uses of the verb 'to be' which include:

- Present Tense: I am, He/She/It is, We/You/They are.
- Simple Past Tense: I/he/she/it was, We/you/they were.
- Infinitive Form: be.
- Present Participle (Gerund): being.
- Past Participle: been. [39]

More importantly, I will bring out the idea of radical externality in physics and philosophy which had the effect of suspending much of classicism's assumptions over a gaping void. This statement does not imply the negation of classic physics. Classic physics can be viewed as a limited case of quantum physics, given certain assumptions. But quantum physics has a spectacular excess to classical physics. I believe the current trend towards authoritarianism and away from democracy cries out for the kind of analysis undertaken in this book. Even more so, with the impending threats of climate change and nuclear annihilation we have little time left to get this right. The writings of the French thinker Emmanuel Levinas (1905-1995) have a breathtaking timeliness to how all these enormous disruptions affect how we think of and relate to our day-to-day encounter with others. In my opinion, Levinas has a beautiful, radically different approach. Perhaps by muse, we might find his approach hinted at in quantum physics. In Levinas's writings of radical alterity (otherness) - the face-to-face encounter of the other we will find a very different kind of ethics which I will distinguish at times as the capitalization of Ethics.

As mentioned, *phusis* has the very ancient idea of growth which

combined what we think of now as philosophy and physics. This notion of 'growth' in the 6th century BC was out of chaos. As we will see, this idea is much like the 'universal wave function' branching or collapsing from chaos. This will be a major theme of the book. *Physis* represents the intrinsic essence of natural development, and its significance extends beyond ancient Greek philosophy into Rome where a transformation as *meta* (beyond or first, e.g., metaphysical) signified origin, birth, and rule. These etymological migrations through Western philosophical thought as a whole tell us something important about how ancient, worldwide notions of growth transformed into notions of origin, essence, and being much later in Rome and beyond. Later, I will discuss how these changes in language tell us about important historic movements after Rome ceased its 'paganism' and became Christian under the reign of Constantine the Great during the fourth century. I will also track these transformations from the Romans to the present day. It is difficult to overstate the importance of how the earliest ideas of *phusis* were intimately both science and philosophy.

This book will explore how ancient notions of *phusis,* emergent from chaos, have much in common with 20th century relativity, quantum physics, and philosophy. Once again, they have united. But the consequences have yet to filter down into common language. Nevertheless, we are feeling the impact on culture and values. As I will discuss, this goes a long way towards understanding how we are currently facing an abyss in which language as meaning-bestowing is hollowing itself out from the inside. The 20th century's astounding and quite extreme findings in relativity, quantum physics, and postmodern philosophies cannot bear the weight of previous meanings of language. Between the earliest notions of *phusis* and the 20th century, histories lost, differentiated, and reduced ancient intuitions along disparate historic and linguistic paths. I plan to trace how this happened through those histories. Fast forward to the 20th century, quantum physics with its bizarrely spooky radical externality and the

philosophy of Emmanuel Levinas with its radical alterity (otherness) and once again we are finding physics and philosophy coming back together and bringing with them a manifold of sciences. As such, this book will mark the historic separation of philosophy and physics with two major sections entitled: "*Phusis*: Towards Radical Exteriority as Physics" and "*Phusis*: Towards Radical Exteriority as Philosophy". More importantly, much of the discussion will investigate how both physics and philosophy have once again come back together. And from recent history which announces their coming back together representing a much more nuanced, beautiful, and fascinating reunion. What hints, limitations, and inferences may be drawn concerning our treasured notions of love? How can our loves interrupt our monologues which desire to consume them as Narcissus' retreat? Towards the end of this book, I will make inferences from the material covered about how our lived experience of love might be affected by the discussion.

One important note here, I have been told on good authority that my writing is difficult to read, and it is. I apologize. But these topics are not easy. I know I have the philosophical *dis-ease* of using a lot of phrasing in a single sentence to clarify points. But lest you think this pertains only to philosophers, physicists also do this with mathematics. I have a friend who is a retired quite well-connected theoretical physicist. However, he was more a theoretical, pure mathematician (as opposed to applied mathematician). He made it clear to me that physicists and mathematicians also practice this kind of verbose obfuscation. He actually had another expression applying to the male gender which I will not repeat. In any case, people dear to me have me in recovery and I am trying to learn how to write in complete simple sentences. I expect to do many more revisions of this document to approximate this goal. When I first started reading compound philosophical sentences I had to slow down and learn a technical trick. When you see a comma separating multiple phrases in a sentence, they are all meant to describe something about the main point of the sentence. Just take

this as alternate ways to think about what is being stated in the sentence. This tendency of philosophers is not like a run-on sentence which conveys different points (which I try to avoid). Academics are also prone to using passive voice. I understand the clarity of the active voice and I try not to do this (but I know I fail and lapse back at times).

I hope to reawaken a sense of wonder which may best be described as radical alterity. Alterity is a word that will be used repeatedly throughout this book. Alterity means 'otherness'. From Latin, *alter* meant the 'other of the two'. [40] Extreme findings in the physics section of this book will be closely aligned with Einstein's colloquial use of the word 'spookiness'. Otherness in the philosophy section of this book will no longer find the spookiness of physics but will be taken up from all too familiar echoes into a radical alterity in the face of the other. [41] What both 20th century physics and philosophy share is a sense of excess for which commonsense finds no easy categories for, no simplistic off-ramps which relegate the other to the contrary of the same. When the other becomes a logical opposition, it becomes the evil other. In logic and its popular reduction to 'commonsense', sameness is consistent with familiarity and otherness is consistent with alienness. In common vernacular, this translates to sameness as true and good and otherness as false and bad. In this fashion, a totality of 'sense' is achieved and maintained which necessarily excludes any possibility for excess to itself, for the other of the two. However, as we shall see, the question that will be brought before us is, "Is there an excess to this totality"? Physics tells us there is an excess in "spookiness" and that is where we will start to explore an extreme excess to the history which founds the truths of commonsense and totality.

We have become sociologically prisoners of narratives from history, culture, and language, increasingly socially and individually constricting. This narrowing of possibilities for the most part has gone unnoticed by most of us. However, the proof we see of this is the inevitable rise of desperation, violent extremism,

and illusory desires which, on one hand, grasp back at reactionary narratives of the past and, on the other hand, gravitate towards authorizing these fictions of the past with authoritarianism. By gaining space from reductionary narratives of abstract 'senses' which are 'common', for the first time, we have the possibility to find a face-to-face encounter with the other which can no longer rest in dogmatic certainties. The exasperation we feel of the other is not the other at all.. It is our Narcissus face, the face of sensibilities which have been concretized as common sense, the thinking machine's war of all against all.

I want to make one thing clear because if anyone ever reads this monolith, I can hear it now from someone, "So, you are saying commonsense is total nonsense and classicism is evil and corrupt". No, that is not what I am 'saying'. Practically, commonsense is necessary if you want to navigate day-to-day and have a successful life. And I love many things about classicism. Certainly, nothing is perfect, and flaws abound everywhere. I do believe there are excesses in both commonsense and classicism which serve destructive ends. One important note about the word 'classicism'. Typically, classicism can refer to a specific period in history from the Greeks to the Romans. It can also refer to other periods of art history from the mid-18th century to the mid-19th century. For the purposes of this book, I will refer to classicism as all histories which occur from the collapse or branching of the quantum wave function (don't worry about that for now). I will discuss the excesses that may cause us to continually not learn from history and perpetuate needless and unnecessary violence. I believe that context and perspective are always a good thing. And quantum physics has an amazing capacity to do just that which all the philosopher's academic gyrations (of which I include myself) will not have the reach that quantum physics *may* have if people are exposed to it. Why? Because modernity has to a large degree either replaced or made peace with the more ancient certainties of God and religion in favor of science. We tend to feel like science has a degree of truth

about it. And I think it does. But many people are not familiar with revolutions in science since the 20th century which abound with fresh new perspectives which I believe could benefit all of us at the current crossroad of the implicit failures of modernity and classicism to renew themselves. It seems we are facing a staleness of history in which a certain kind of desperation and despotism are indicators that doing the same thing over and over again is not working and even more, are counterproductive at this stage in history. I am going to try to explain some things which are very hard to understand. I will try to use analogies and visual images when I can as I think they are helpful. So, just realize that I am not off my meds (or on them), and I am not writing this while consuming copious amounts of alcohol. As the youngsters say, "Chill!".

This book is not meant for academics. I am not putting down academics. I have learned and continue to learn many amazing and even life altering meanings from them. But there is one thing that makes meaning possible, what we bring to the table. Language has two aspects to it. Language can be habit and routine culminating in simple common sense, how to get around in our everyday world. This is the passive mode of language. Language can also be like star gazing. It can take you to incredible places which will blow your mind and inspire you just as well as the most beautiful song you ever heard. But this mode of language is active. In this mode you need to bring yourself to the table. Effectively, this means do not be afraid to speculate even if others are all too willing to put you down for it. No matter what pretense folks may have, no one knows it all. We are all on a quest, even those who have devoted their lives to academia. And we all have the same pitfalls along the way. To the degree that we have arrived is to the same degree that we fall back into the passive mode of habit and routine. In the passive mode there is only one 'quest' left to do – defend. Defensiveness turns off the passion of growth. Growth is life. The alternative is death. We choose. In this book I will not shy from what I am certain others

would call unfounded speculation. I admit from the start that I am unfounded. Finding myself is about growth, learning, changing. All of this brings passion and a sense of fullness to life. For me, the alternative is to simply hang around listening to my own stagnant echoes of myself until death mercifully ends the language game. Did you ever think why little children are so amazing, full of life even in the worst of situations? It is because they reset from square one. They enter life not as a blank tablet but as what I will go into much greater detail – the quantum wave function. Even our neurons at birth are all firing in such a way that makes the movie "Everything Everywhere All at Once" look like a quite boring life.

After birth, the human brain undergoes fascinating changes that contribute to its remarkable adaptability. Most of the brain's nerve cells, or neurons, find their places in the frontal lobe before birth. However, after birth, a large group of young nerve cells embarks on a journey. These neurons migrate into the frontal lobe during the first few months of life. This migration might explain why human babies' brains remain so malleable during this window of time after birth. The circuits controlling learning, memory, and social behavior are highly malleable in early infancy. Connections between neurons are formed and severed repeatedly.

The arrival of new neurons during the first few months could contribute to this prolonged flexibility in babies' brains. These neurons start as a cluster in the subventricular zone, a layer inside the brain where new neurons are born. They then form a chain, moving into the frontal lobe. Later in development, most of these migrating neurons become inhibitory interneurons. These neurons act like stoplights, regulating signaling between other neurons. Remarkably, the migration process continues for months and months after birth, shaping the brain's responsiveness to the environment. Although all the neurons in the cortex are produced before birth, they are initially poorly connected. The cerebral cortex, responsible for higher-order functions, produces most of its synaptic connections after birth. This massive burst of synapse

formation is known as the exuberant period. During this time, the brain establishes crucial connections that contribute to learning, memory, and overall cognitive development. The brain's dynamic changes after birth involve neuronal migration, circuit formation, and synaptic connections. These processes contribute to the brain's adaptability and capacity for learning and growth. [42] New human life tells us something very wise about ourselves and how to live. If we want passion, fulfillment, and meaning throughout our life we need to aspire to be like little children. Open and eager for the other, to learn, to grow, and to do it with vigor, the expectation of novelty, to have a kind of fascination whose ethic is open and welcoming, expecting without already knowing. Later I will refer to this as one of the most ancient myths of humanity predating the book of Genesis – the tree of life.

In my opinion, the state of infancy is close but not exactly what the quantum state of superposition of the wave function is getting at. More on all that later. But after childhood we are faced more and more with two choices. We can simply stop growing, learning, and speculating, or we can *exercise* those habitual paths, connections between neurons, we have established through life instead of simply hanging around waiting to die (which is what I refer to as transactionalism). Everything becomes a game of one upmanship, pride in winning, which is really only the perception of winning because in this kind of winning you never lose or win, you just boost your own idea of yourself at the expense of the other. Throughout this book I will repeatedly use the word 'echo' to indicate this kind of behavior. 'Echo' is the end of growth. 'Echo' is welcoming death. Certainly, as Nietzsche would have it, we can rise to the "noble morality" of echoing the eternal return of ourselves to ourselves or as he would have it, affirming the utter and absolute tragedy of life in a way which "breathes the higher air" and creates "higher values" and designates the "ascendent" ones over the "ignoble", "decadent" "valley" dwellers. Nietzsche makes me wonder why Zarathustra would ever go down from the mountain in

the first place to the valley folks below. Why didn't he just stay in his "high places" and not bother with those valley folks which he "pitied" to the point of despising? Here is what Zarathustra tells us why he "went down" from his "glory" and "high air" mountain to the pitiful below:

> Thou great star! What would be thy happiness if thou hadst not those for whom thou shinest!
>
> For ten years hast thou climbed hither unto my cave: thou wouldst have wearied of thy light and of the journey, had it not been for me, mine eagle, and my serpent.
>
> But we awaited thee every morning, took from thee thine overflow, and blessed thee for it.
>
> Lo! I am weary of my wisdom, like the bee that hath gathered too much honey; I need hands outstretched to take it.
>
> I would fain bestow and distribute, until the wise have once more become joyous in their folly, and the poor happy in their riches.
>
> Therefore must I descend into the deep: as thou doest in the evening, when thou goest behind the sea, and givest light also to the nether-world, thou exuberant star!
>
> Like thee must I go down, as men say, to whom I shall descend.
>
> Bless me, then, thou tranquil eye, that canst behold even the greatest happiness without envy!
>
> Bless the cup that is about to overflow, that the water may flow golden out of it, and carry everywhere the reflection of thy bliss!
>
> Lo! This cup is again going to empty itself, and Zarathustra is again going to be a man.
>
> Thus began Zarathustra's down-going. 43

Thus, forever the sacred echo which no longer needs to aspire

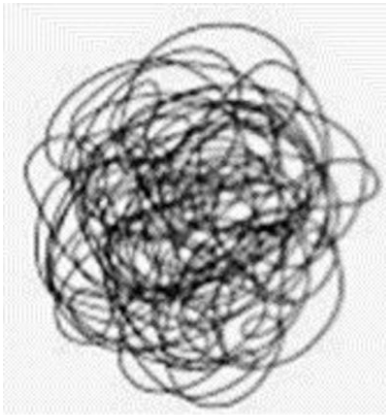
overflows itself so much so that everyone thereafter will be 'blessed' by Zarathustra's final triumph which only requires his own glory, but somehow could not remain on the mountain because *the sun is not content to shine upon itself*. Nietzsche tells us either you buy the myth of arriving as the blessed one, affirming the utter tragedy of "eternal recurrence", absolute and utter sameness, or you regurgitate from the "Great Nausea" of despising existence. One makes you the rare 'ascendent one' and the other makes you the common 'descendent ones'. This sounds to me like it could be a board game or perhaps better how to live transactionally at the expense of others. Zarathustra calls this 'life' but it seems to me like the end of growth, having arrived, and 'enjoying' the *idea* of having won the transactional game finally and completely. This is the life-long illusion which informs all of us that *mythically*, one day, we will win, beat all the other 'players' and *reign on high forever as the ultimate, absolute champion of the existence game*. Isn't this yet another religious myth or is it more akin to a gambling addiction? I will have much more to say about this as well but for now I find this to simply be yet another way to simply and transactionally reaffirm oneself at the expense of the other. I believe valuing the other sets one on a path for growth, passion for life, and for emergence and novelty. This is not Zarathustra. This is the joy, beauty, and wonder of the little child.

One more thing about language. As passive, language develops rutted pathways which conveys a firmly rooted narrative of 'reality', the 'way it is'. In this case, any other which messes with our certainties is the evil bad-faith other of our echoed imaginings. One example of how this works itself out is with pronouns. Many folks complain or simply laugh about a new contemporaneous narrative which contests binary pronouns of he and/or she. Some prefer binary pronouns which affirm themselves not just their biological gender. Others prefer nonbinary pronouns which do not affirm a binary gender and yet are not relegated to the category of neutrality such as 'it'. I am one who simply took it for granted that

my biological gender and pronouns were in agreement. But I have found that there is a really cool opportunity in all this to take a fresh perspective.

The alternate pronoun narratives present us with a choice. Either we can simply laugh it off, writing off 'those people' as idiots or perhaps we can choose to learn something. I find this whole discussion very interesting; it makes us aware of how we are often oblivious to the ways language conditions us. Many languages go so far as to even have pronouns embedded in nouns. So even 'things' (or the more *relatively* recent but historic notion of neutrality…more on that later) have gender (harkening to perhaps an ever more ancient language of animism…animate-ism). If nothing else the alternate narratives of gender and conformance to pronouns are a springboard to asking ourselves, "hmm, they may have an interesting point here". These discussions may cause us to actively reflect on how language in the passive mode simply bestows on us assumptions as 'true' and perhaps at the expense of the other. So, the choice is to simply and passively accept prepackaged and ready to use 'truths' or look for ways to use these alternate narratives to actively question language as a springboard for learning something about ourselves. I find the latter to be more positive and life affirming. In any case, in this book I will generally use the pronouns he and she for brevity. However, I do acknowledge the validity of those that take issue with how these terms, and how language itself, can be used to precondition us to be passive, oblivious, and unaware of possibilities which might actually enhance our lived experience - if only we would put a little reflective thought into who we are and what we do on a day-to-day basis.

In this Book Chaos is not Disorder



Chaos (License Agreement)

Throughout this book I will be continually coming back to the idea of chaos. Historically order proceeds from cause and effect founded on origin. The etymology of our Greek word for origin is ἀρχή. This word meant beginning, sovereignty, dominion, authority. [44] Origin is the signet of order, the royal seal of history. Derrida calls this logocentrism (*logos*-centric). *Logos* is an ancient Greek word which is difficult to translate. *Logos* is an organizing principle. It is how thoughts get arranged. *Logos* is also a generative principle of the universe. *Logos* is usually translated as 'word' or 'discourse'. But it also means the 'word' within. [45] Maybe the closest we can come to understanding its meaning and scope is to think of it as what we mean by the word 'reality'. The *logos* taken up and transformed into later Greek thought and Rome becomes logic and order and then divine proclamation. *Logos* in later Greek thought as order and logic implies disorder, the contradiction of order and truth. In Jesus, the 'word (*logos*) becomes flesh'. [46]

Logic and divine proclamation of order must necessarily bring with it disorder and all the negative attributions of evil from Western history. Disorder must necessarily follow as order's evil twin. Disorder is the contradiction of order, the 'not' of order, and *vice-versa*. Order and disorder are binary poles where good and evil

play. There is a necessary bipolar relationship here which cannot allow any excess to its dualistic paradigm and the polarities in which it plays. In this book, I will repeatedly explore how historic, totalizing dualities play throughout history sealing themselves off from any possible exteriority which could topple their dominion, their rule of origin. Certainties which arise in commonsense of our everyday world are *logos-centric*, historic narratives which give us a commonsense feeling of what 'is' and what 'is not'. It conveys a fully accounted-for understanding of practical reality. This serves us in our day-to-day functions. However, practicality also introduces a downside in the form of a binary ethos (the characteristic spirit of a culture, era, or community as manifested in its beliefs and aspirations) rising from commonsense pre-understandings. Pre-understandings are not explicit foreground reasoning but environmental backgrounds which are necessary for day-to-day functionality. But they are also more than that. They also form a basis for our values, our *ethos*. As such they have a totalizing effect on our judgements. When pre-understandings of order and disorder are translated into subjective values, they fully account for any excess or externality. Effectively, value judgements are sorted between the pole of order and disorder. They function practically as complete categories, as degrees of either-or. Either-or as totaling poles where good or evil become 'logical' in the play of order and disorder. In the case of either-or, chaos is taken as a synonym of disorder.

Let's be very clear about what chaos is **not** in the context of this book. Chaos is not disorder. Order and disorder belong to a conventional historical hierarchy of binary oppositions. Together they form a totalizing oppositional unity to each other setting up a bipolar opposition wherein all degrees of order and disorder are fully accounted for. There is no excess or alterity which can exceed our lived symbiotic identities of order and disorder. As we shall see, our Western histories of rationalism, logic based on identities and contradictions have enabled our commonsense to orient our day-to-

day practicalities and values into reductive avenues bounded by either-or. This pattern of habitually and dialectically obliviating any excess to already understood, assumed categories gets repeated in many other ways which will be illustrated throughout this book. For the matter at hand, chaos will be vastly different from disorder. In terms of physics, chaos must break away from commonsense opposition as disorder, the 'not' of order, and instead retain a spooky externality which is neither order nor disorder.

It is important to note that dualities and binary oppositions also arise frequently in quantum mechanics. As we shall see, physicists even have a name for it, complementarity. [47] But complementarity had an interesting twist from either-or. Complementarity is the contradictory principle of both-and. For example, quanta are both wave and particle which is contradictory but nevertheless both are maintained as true (which strikes at the heart of 'truth'). Complementarity was a word that put lipstick on a pig because it fit better with the history of classical physics in the early 20th century at a time when quantum physics was struggling to be taken seriously. But the word that most appropriately describes these new discoveries is 'contradiction'. The difference between binary dualities in classical history and in quantum physics is that many of these dualities will have an underlying spooky excess to them which cannot be accounted for by history, language, culture, and even commonsense.

From an absolute classical physics perspective, inferences of chaos might be associations made by the reader concerning conditions physics calls the observer effect, superposition, and indeterminacy. Superposition is a mathematical term used to describe the quantum wave function. The quantum wave function is a strange alterity from classic physics, classic philosophy, classicism in general and their offspring, 'commonsense'. Entanglement is not some isolated eccentric exception of physics but is '*the characteristic trait of quantum mechanics*'. The quantum wave function underlies and in a sense gives rise to what we think of as 'reality'. It has

tentacles in our lived experience, our conscious and unconscious, our molecular biology, and is responsible for emergence and novelty in many ways including evolution. For now, here are a couple of definitions of superposition given by two very renowned physicists.

> The general principle of superposition of quantum mechanics applies to the states [that are theoretically possible without mutual interference or contradiction] ... of any one dynamical system. It requires us to assume that between these states there exist peculiar relationships such that whenever the system is definitely in one state we can consider it as being partly in each of two or more other states. The original state must be regarded as the result of a kind of superposition of the two or more new states, in a way that cannot be conceived on classical ideas. Any state may be considered as the result of a superposition of two or more other states, and indeed in an **infinite** number of ways. Conversely, any two or more states may be superposed to give a new state...
>
> The non-classical nature of the superposition process is brought out clearly if we consider the superposition of two states, A and B, such that there exists an observation which, when made on the system in state A, is certain to lead to one particular result, a say, and when made on the system in state B is certain to lead to some different result, b say. What will be the result of the observation when made on the system in the superposed state? The answer is that the result will be sometimes a and sometimes b, according to a probability law depending on the relative weights of A and B in the superposition process. It will never be different from both a and b [i.e., either a or b]. The intermediate character of the state formed by superposition thus expresses itself through the probability of a particular result for an

> observation being intermediate between the corresponding probabilities for the original states, not through the result itself being intermediate between the corresponding results for the original states. [48]
>
> Paul Dirac

> "[T]he superposition of amplitudes ... is only valid if there is no way to know, even in principle, which path the particle took. It is important to realize that this does not imply that an observer actually takes note of what happens. It is sufficient to destroy the interference pattern, if the path information is accessible in principle from the experiment or even if it is dispersed in the environment and beyond any technical possibility to be recovered, but in principle still "out there." The absence of any such information is the essential criterion for quantum interference to appear.
>
> Anton Zeilinger [49]

The quantum wave function and entanglement are responsible for what I am calling 'chaos'. Chaos embodies order and disorder and their excess. There is a very odd kind of determinism in the wave function which fits with our notion of order. There is also a very odd phenomenon called (for now) wave function collapse which gives rise to classical physics and philosophy. I will simply refer to this as classicism. Wave function collapse, as the excess of origin, turns out to be the metaphysics authorizing rule and authority which cannot abide indeterminacy and uncertainty. Origin matriculating down through the centuries gets taken as 'logic' and 'commonsense'. Entanglement is before spacetime, most likely gives rise to spacetime (think of the singularity in cosmology's Big Bang). Entanglement is '**the** characteristic trait of quantum mechanics'. As such, what we think of as 'spacetime' are historic narratives that our history has spun around innumerable and incessantly transforming entangled systems which include us.

This means entanglement is not just something which happened in the cosmological Big Bang, it is happening all the time everywhere in the universe. And since entanglement is prior to and gives rise to spacetime this means it is before cause and effect. Together superposition and entanglement will not be just another idea we can easily assimilate. Anyone who seriously contemplates these topics will not find an easy idea to categorize them but will feel an emotional uneasiness, a haunting inability to pigeonhole these ideas and implications. These topics will feel like a gaping chasm, an abyss which looks back at us. But if one takes up the struggle, these feelings of unease and chaos, one will find radical alterities which face us and call us. They call us away from our deliberations, our truths. They call us to what exceeds our feeble categories of logic and noncontradiction which underwrite the validities of our commonsense judgements of each other. In these ways chaos best describes order and disorder and all the ways our everyday lives make judgements about what falls into each category. But most of all chaos exceeds these binary dualities in novel and unexpected ways. Perhaps one could make a case that in our earliest beginnings ancient sages all over the world intuited what now looks us in the face from the abyss.

There is something hinted at in the ancient Greek writings of *phusis* before the bipolar split into physics and philosophy. In this book, chaos will not reside in binary oppositions of order and disorder, subject and object, or even in totalizing dualities of self and other. Neither does chaos reside comfortably in either physics or philosophy. Chaos has a spooky, indeterminate relationship with both physics and philosophy. The chaos of quantum physics has been papered over by history in our daily, practical lives. The reader is asked to listen for something vastly other, not easily assimilated, and a feeling of inability to find familiar words, categories, and thoughts which are accessible and comfortable. I will try to the best of my ability to bring to the fore the abyss which motivated Einstein to employ the very unscientific word ‘spooky’ to

describe the implications of quantum physics. Many others after Einstein who were and are giants in quantum physics have also been confounded in ample writings with the vertigo of this chasm. Both in the early twentieth century and later, important physicists have even resorted to modernity's scientific distaste for all things philosophical in an attempt to make sense of their discoveries. Why? Because the spooky cannot rest in the binary opposition of science and philosophy. There is an uncomfortable lack which shows up inadequacies, crevices, and fractures to how history has oriented us to 'reality'. So, what is meant by the discomfort of chaos? In this book chaos in quantum theory will be explored along the following lines (don't worry for now about understanding this):

- Quantum probability, uncertainty, and indeterminacy underlying all forms of classical epistemology and ontology (categories of knowledge and categories of existence).
- Quantum superposition as the infinite, simultaneous status of transitional ontic (real) states where the status of superposition itself is indeterminate in classical epistemology and ontology.
- Quantum observer effect oblivious to classical, binary categories like subject/object, self/other (of itself), order/disorder, essence/existence, inner/outer, etc.
- Quantum entanglement as chaotic informational complexity meaning pre-spacetime, cause and effect, in which spooky, externality makes way for emergence and novelty.

I will also discuss the case of quantum chaos theory which tries to recover classical chaos theory as a limited case. Here is my thought on this subject for now:

If classic physics is a limited case of quantum physics, we

> will have to find all the paths which lead us from the chaos of classical indeterminacies based on infinitesimals of initial conditions to a chaos where infinite, simultaneous possibilities of superposition live alongside infinite branching paths from one quantum state to another all of which involve 'the characteristic trait of quantum mechanics' as entangled, from which spacetime emerges as novel, and inseparable from the observer effect or perhaps simply what Einstein simply called "spooky".

The discomfort which calls us away from our typical categories of understanding which bubble up in commonsense should lead us towards serious and fundamental reflection into our historic grounding. In the latter half of this book the spooky will dissipate into a radical externality which cannot rest easily in our familiarities with other people. An excess of the other is upended by sameness in our sense of familiarity with others. The sameness implied in our familiarity with others has cast us into violent repetitions of war and tragedies. Sameness consummated by totalizing binary oppositions gets caught up in the ego, the 'I', which relegates the other to my idea of the other and in so doing loses the otherness of the other, the gap of chaos which 'my idea' cannot cross. When the other is the same as my idea of the other, there is no excess, there is only an occasion for transactionalism, the satiation of the self at the expense of the other. The ethics which arise in the context of 'my idea' of the other only can be relegated to altruism as an appeasement for bad conscience from the reduction of the other to the same.

Please note that I do not believe altruism is simply reduced to this as it certainly has an externality which exceeds the conscience of the benefactor. Altruism is beneficial and needed for the indigent and victims of poverty no matter what any motivations might be. But altruism has never been able to solve many of the problems of human suffering which we are fully capable of alleviating. My

comment on appeasement means to underscore that altruism is a Band-Aid for a more rooted problem which keeps getting repeated. Altruism does not address why we perpetually need altruism. Whatever pseudo rationalizations of our inhumanity to others, whether it be original sin or patting ourselves on the back for trying to make a dent in starvation and extreme poverty, this is no occasion for relief as appeasement of conscience. Especially, regarding a radical externality which calls us to responsibility for the other before we have an answer (an idea), even before the 'is' of all our certainties. As I hope to make clear, our totalizing ideas of the other cannot address our debt to the radical alterity of the other. Through the course of this book, I believe the spooky chaos of physics will lead us towards a still, small voice from radical alterity not known by the sameness of the other but in the cry of responsibility from which we flee - the other which finds no home, no origin, no history in my idea or Idea.

A Brief Overview of the History of Philosophy and Science

As the trade hub of the ancient world, ancient Greek thought was influenced by Egypt, Babylon, Lydia, and Phoenicia. [50] Our Western, historic underpinnings concerning the Christian metaphysics of God started in earnest during the fourth century [51] with the Roman Emperor Constantine the Great converting to Christianity. Prior to this, Plato (428-348 BC) thought his notion of what he called the 'Forms' was not really thoughts or ideas as simple mental concepts. [52] The Forms were barely distinguishable phenomena which guided people's thoughts of reality, truth, and virtue. The Forms cast shadows that we take as 'reality', as meaning. In the context of more ancient Greek philosophy, form or *morphē*[53] was suspended over an origin of chaos or yawning gap for Hesiod, ceaseless change, or flux for Heraclitus (540-480 BC), origin and destruction, order and justice, as the ordinance of time for Anaximander (610-546 BC), potential and actual motion for

Aristotle (384-322 BC). At this point I want to interject some comments about a theme I plan to come back to a number of times in various ways.

> In botany and dendrology, a rhizome (/ˈraɪzoʊm/; from Ancient Greek ῥίζωμα (rhízōma) 'mass of roots', from ῥιζόω (rhizóō) 'cause to strike root') is a modified subterranean plant stem that sends out roots and shoots from its nodes. Rhizomes are also called creeping rootstalks or just rootstalks. Rhizomes develop from axillary buds and grow horizontally. The rhizome also retains the ability to allow new shoots to grow upwards. [54]

In philosophy, a rhizome is a concept that originates from the work of French theorists Gilles Deleuze (1925-1995) and Félix Guattari (1930-1992). A rhizome is a nonlinear network that defies traditional hierarchical structures. It appears in their book “A Thousand Plateaus” and describes networks that establish “connections between semiotic chains, organizations of power, and circumstances relative to the arts, sciences, and social struggles.” These connections lack apparent order or coherency. Unlike a tree-like or hierarchical structure (such as hypertext in literary theory), a rhizome is purely a network of multiplicities with properties like lattices. Any point in a rhizome can connect to any other point. There are no fixed paths or predetermined hierarchies. Rhizome is extreme plurality. It embraces diversity and multiple entry points. Rhizome is a non-linear movement. Rather than following a linear chronology, rhizome favors a nomadic system of growth and propagation. Culture and knowledge spread like the surface of water, seeking equilibrium, and leaving no trace of disturbances. Rhizome is contrasted with arborescent models. An arborescent model (tree-like) works with dualist categories and binary choices. In contrast, rhizome operates with planar and trans-species connections. Rhizome resists chronology and organization,

presenting history and culture as a map of attractions and influences without a specific origin or genesis. Deleuze and Guattari use the biological concept of mutualism to illustrate rhizome. Just as an orchid and a wasp interact to form a multiplicity, rhizome connects disparate elements. Remember this for later, rhizome is not just a botanical term; it's an image of thought that apprehends multiplicities and challenges conventional ways of understanding interconnectedness. [55] This will be a theme I will return to in a number of different contexts.

In the archaic period of ancient Greece (800 to 500 BC), Homer and Hesiod were writing their epic works, the Odyssey and the Theogony somewhere around 750 to 650 BC. [56] In 539 BC the Persians of the Achaemenid Empire conquered Babylon. At the end of the ancient Greek, archaic period, we have Cyrus the Great of Persia allowing the second temple of Judaism to be built. Scholars believe this led to the Hebrew shades of the 'tree of life' [Hebrew: *etz chaim*] found in Genesis 2:9 (Jean-Louis, 2006). At about this same time Heraclitus and Anaximander were branching off into notions of origin, ultimate completion or fulfillment, chaos, and form. From these roots Aristotle and Plato were exploring the themes of form, and order and logic as *logos*.

The earlier Greek notions of origin, ultimate completion or fulfillment, chaos and form were motivated by a sense of wonder and beauty which had not yet solidified into the everyday language, culture, and history in ancient Greece. Art and sculpture, poetry and drama, science and philosophy, were spawned by budding philosophies gazing upon the wonder of some strange alterities - the breath of the gods awakening alien otherness in mortals as alpine temples of promise. It is hard for us sitting millennia later to breathe these heights. Our 'common sense' and day-to-day are invisibly borne in their forgotten language which long ago lost imminence as otherness; otherness not yet tamed and conquered. And now, another sapling has sprouted an odd externality, different from the classics and modernity. Its recognition has been shaded by

an over-rich *rhizome*, an overtired history that levels off and dismisses even such a possibility as an other to this history we call being and reality. A new seedling now stirs away from the ancient other of Greece which spawned Western history. Perhaps this new sapling was prophetically foretold by a radical externality which spawned our history of being from ancient Greece to the present. Philosophers call our inherited history of being – ontology [from Ancient Greek ὤν, ὄντος (ὅ*n*, *óntos*, "being"), present participle of εἰμί (*eimí*, "being, existing, essence") + λόγος (*lógos*, "account"]. 57

Neoplatonism started in the third century and stretched to the sixth century. Its cultural influences were Greek, Persian, Indian, and Egyptian. Its philosophical beginnings were a mix of Islamic, Hebrew, Christian, Gnosticism, and mysticism. Over time it consolidated into monotheism, one God. This is where the idea of God as beyond being and non-being and beyond all categories of understanding congealed into Western history. It also acquired the idea of the 'world-soul'. The world-soul was the Greek *nous* or mind originating from the monotheistic God. It was the sum total of all human souls. This is where the mind of humans took on the attributes of its creator. The conflict between these notions of God and phenomena led to the contingency of becoming. This contingency was the source of evil. Evil was not a being but a necessary result of the strife and struggle of existence. Christian evil as Satan came later.

The confluence of science during this period came from much more ancient cultures like Mesopotamia (the Near East), Egypt, Persia, Greece, Rome, and even Asia. The origins of algebra and the Pythagorean Theorem are believed to go back to 1,800 BC in Babylon and Egypt. The Greek philosopher Pythagoras stated it explicitly in the fifth century BC. Ancient origins of math, alchemy (chemistry), written language, and astronomy were found that far back as well. Science during this period was infused with religious philosophies typically performed by priests. Some have referred to this period as the first scientific revolution.

Most scientific and technical innovations until the scientific revolution (1543-1687) were achieved by societies organized by religious traditions. Ancient pagan, Islamic, and Christian scholars pioneered individual elements of the scientific method. Roger Bacon (1220-1292), often credited with formalizing the scientific method, was a Franciscan friar. However, the concepts of “science” and “religion” are a recent invention: “religion” emerged in the 17th century during colonization, globalization, and as a consequence of the Protestant reformation. “Science” emerged in the 19th century during attempts to narrowly define those who studied nature. 58

Alchemy is a form of speculative thought that aimed to transform base metals such as lead or copper into silver or gold and to discover a cure for disease and a way of extending life. It was not conclusively disproved by scientific evidence until the 19th century. Today, alchemy is considered a pseudoscience. However, the roots of alchemy can be traced back to philosophy, astronomy, and religion. The practice of alchemy was widespread in Europe during the Middle Ages and the Renaissance period. It was also practiced in other parts of the world, including China and India 1. Although alchemy and science share some similarities, they are fundamentally different. Modern science is based on empirical evidence and the scientific method, while alchemy is based on mystical and spiritual beliefs. Therefore, alchemy is no longer considered a science but rather a form of pseudoscience. 59

The roots of Christian metaphysics go deeply into 3rd through 5th century Neoplatonism60 which became the Hellenistic teachings of Plato adapted to Latin in Rome. The translation from Greek into Latin was a transformation which informed the early writings and philosophy of Christianity. This transformation left behind much of the richness of the ancient Greek world and adapted that world to the budding Roman empire. The Roman empire started with many of the ancient Greek myths and philosophies. The Neoplatonists infused Roman culture with Greek history strained through the Latin lens. When Constantine became emperor, he converted to the

newly formed religion of Christianity and moved the political center of Rome to Constantinople. Christian Rome again strained Neoplatonism through the lens of Christianity. At this point I want to take a brief step back and look at the ancient history of *logos*.

The ideas of logic and continuity have historically been set against the ideas of the chaotic, erratic, and random. Contradiction is thematically set up *as* the opposition of logic and continuity. Logic is *logos* [λόγος] in Greek. Logic, as the principle of noncontradiction clearly articulated by Aristotle, plays a major role in Western history and even in common discourse given by common sense. So, let's look at *logos* with more focus on Heraclitus. Many philologists who study Heraclitus' ancient texts agree that the logical sense of *logos* is anachronistic, meaning not applicable to the period of Heraclitus.

> Some do not think that λόγος in Heraclitus is a technical term. They see it just meaning "account." Heraclitus, to these scholars, is giving an account of the universe just as any other philosopher or natural scientist might do. Kahn points out that many treatises around this time began with a reference to λόγος or discourse as such (97). [61]

Heraclitus had no inherited history of classicism. He was prior to later Greek notions of logic, but he had *logos* from which we derive the word logic. Philology as the scholarly study of the classics is highly suspicious of anachronisms or assigning meanings to periods —to texts and writers, in periods which are inappropriate to another period, to the extant texts and writers of their period. With this in mind, let's look at Heraclitus' account of *logos* from various reported fragments.

Though this Word [logos] is true evermore, yet men are as unable to understand it when they hear it for the first time as before they have heard it at all. For, though all things come to pass in accordance with this Word [logos], men seem as if they had no

experience of them, when they make trial of words and deeds such as I set forth, dividing each thing according to its kind and showing how **it is what it is**. But other men know not what they are doing when awake, even as they forget what they do in sleep. 62

> Though the logos is common, the many live as if they had a wisdom of their own. 63
>
> Traveling on every path, you will not find the boundaries of soul by going -- so deep is its measure [logos]. 64
>
> Most are at odds with that with which they most constantly associate -- the account [logos] which governs the universe -- and ... what they meet with every day seems foreign to them. 65
>
> The fool is fluttered at every word [logos]. 66
>
> Of all whose discourses [logos] I have heard, there is not one who attains to recognizing what is wise, set apart from all.
>
> -- or --
>
> Of all whose discourses [logos] I have heard, there is not one who attains to recognizing that the wise is set apart from all. 67
>
> The logos of the soul is increasing itself. 68

One school of scholarly thought on *logos*, notably advocated by John Burnet (1863 - 1928), simply means giving an account or discourse.

> In the first place, it should be noted that not all commentators have accepted that the translation of '*logos*' in Heraclitus presents any special difficulty, even in frr. [fragments] 1, 2, and 50. Some have maintained that even in these instances the term can be rendered straightforwardly in accordance with its most common contemporary use. On this 'simple' view, the word '*logos*' is derived straightforwardly

> from the verb *legein*, meaning ‘to speak’: a logos is just something someone says. On this view, there is no reason why this cannot hold also for the term as it is used by Heraclitus: ‘logos’ in Heraclitus denotes simply what he says (i.e. his own account or discourse), and it is a mistake to look for any special philosophical significance in it. [69]

This view of *logos* is archaic in later scholarship. The later history of the word *logos* does not simply mean ‘word’ or ‘dialog’. Throughout this history other scholars and philosophers have attributed many other uses to the word *logos*. *Logos* is a difficult word to describe because it was used after Heraclitus to mean many things. The debate is what, if any, of these additional meanings can be attributed to Heraclitus. Some have argued *logos* has to do with the transformations, the dynamic ordering of the world. Our word logic is not really a good representation for what the ancient Greeks might have thought *logos* meant.

> The λόγος [logos] is the rational principle that orders the universe. At times, it is connected with the divine and with fire. It is linked to the idea of measure and proportion, but mostly to the idea of rationality. All things come to pass according to the λόγος. This λόγος is common in that it speaks to all men. But not all men understand the λόγος. Many turn aside from what is common to make a wisdom all their own. It would be safe to say that the λόγος is similar to God in a pantheistic system. Because human souls are composed of fire, the ideal death would be to join the eternal, ever-living fire/God/λόγος. There is not enough of the fragments left to decipher all the details of Heraclitus' λόγος, but I think a simple rough sketch can be safely made.
>
> Anything written or spoken.
>
> Reason (for doing something) or argument.
>
> Measure, proportion, ratio.

General principle or rule

(faculty of) Reason 70

πολυμαθίη νόον οὐ διδάσκει· Ἡσίοδον γὰρ ἂν ἐδίδαξε καὶ Πυθαγόρην, αὖτίς τε Ξενοφάνεά τε καὶ Ἑκαταῖον

The learning of many things does not teach understanding; otherwise, it would have taught Hesiod and Pythagoras, and again Xenophanes and Hecataeus. 71

ψυχῆς πείρατα ἰὼν οὐκ ἂν ἐξεύροιο πᾶσαν ἐπιπορευόμενος ὁδόν· οὕτω βαθὺν λόγον ἔχει

Traveling on every path, you will not find the boundaries of soul by going -- so deep is its measure. 72

φύσις κρύπτεσθαι φιλεῖ

Nature loves to hide. 73

σάρμα εἰκῇ κεχυμένον ὁ κάλλιστος, φησὶν Ἡράκλειτος, [ὁ] κόσμος

The most beautiful universe is (a) pouring out (of) sweepings at random. 74

συλλάψιες· ὅλα καὶ οὐχ ὅλα, συμφερόμενον διαφερόμενον, συνᾷδον διᾷδον καὶ ἐκ πάντων ἓν καὶ ἐξ ἑνὸς πάντα

Graspings: things whole and not whole, what is drawn together and what is drawn asunder, the harmonious and the discordant. The one is made up of all things, and all things issue from the one. 75

ὁδὸς ἄνω κάτω μία καὶ ὠυτή

The way up and the way down is one and the same. 76

15. The λόγος is primarily the discourse of Herakleitos himself; though, as he is a prophet, we may call it his "Word." It can neither mean a discourse addressed to Herakleitos nor yet "reason." (Cf. Zeller, p. 630, n. 1; Eng. trans. ii. p. 7, n. 2.) A difficulty has been raised about the words ἐόντος αἰεί. How could Herakleitos say that his discourse had always existed? The answer is that in Ionic ἐών means "true" when coupled with words like λόγος Cf.

Herod. 1. 30, τῷ ἐόντι χρησάμενος λέγει; and even Aristoph. Frogs, 1052, οὐκ ὄντα λόγον. It is only by taking the words in this way that we can understand Aristotle's hesitation as to the proper punctuation (Rhet. Γ, 5. 1407 b 15; R.P. 30. a). The Stoic interpretation given by Marcus Aurelius, iv. 46 (R.P. 32 b), must be rejected. In any case, the Johannine doctrine of the λόγος has nothing to do with Heraclitus or with anything at all in Greek philosophy, but comes from the Hebrew Wisdom literature. See Rendel Harris, "The Origin of the Prologue to St. John's Gospel," in The Expositor, 1916, pp. 147 sqq. 77

It seems to me that any idea that Heraclitus is nonsensical, if strained through the principle of noncontradiction, would be anachronistic. From the perspective of a certain history of rationality which followed, Heraclitus would be nonsensical. However, it may be that later in this book we may find Heraclitus, just before the start of the burgeoning epoch of classicism and rationality, may have intuited more than we think. For now, let's look at some of the relevant history which followed from the time of Heraclitus.

The writer of the First Epistle of John was well aware of the Greek *logos*, translated 'Word', when he wrote "The Word of life existed from the beginning" [1 John 1:1]. However, 'Word' as a man, Jesus Christ, is an extreme oversimplification of what the writer of the epistle of John understood in using *logos*. *Logos* was the immense wealth of meaning bubbling through centuries of ancient Greek thought. *Logos* is translated 'word', 'reason' or 'plan' but this is also a transformation. Actually, the idea was much more associated with an ordering which guided thinking. In modern-day notions we might think of this ordering as 'real' or 'what is'. The advent of physics and metaphysics in Constantinople sprouted from the roots of a more ancient tree in the Greek word *phusis*. *Phusis* had even more archaic, deep roots denoting growth. This ancient tree

spreads its *rhizome*[78], masses of roots below and branches above, in later histories of alchemy and classic science, religion and Enlightenment, phenomenology, and relativity. For Plato, *logos* as ordering stood in the shadows of the Forms or *eidos* which is translated as 'idea'.

Philosophy and physics started to diverge in Christian Constantinople in the fourth century. The earliest beginnings of Western alchemy started in Egypt around 3,200 BC. Later, it spread to the Greek, Roman, and Islamic worlds. It was also found in India, Asia, and China. Alchemy was thought by many as science of the day which had elements of chemistry and was spiritually infused with 'pagan' traditions and Christian traditions from Rome.

The early beginnings of the Renaissance started in the 12th century in Europe which gave rise to renewed interest in the ancient Greeks. Johannes Gutenberg invented the printing press in 1436. The Italian Renaissance began in the 14th century and spread to the rest of Europe and many other parts of the world in the 16th century. It accelerated partly from the Black Plague in the 14th century which gave rise to pessimism with the power structure and absurd excesses of the Catholic Church. The abstractions of Catholic spirituality and the Black Plague shifted interest towards realism and human emotion especially in art. This led to the advent of Reformation with Martin Luther, the Church of England splitting from the Catholic Church, and eventually Protestantism. Nevertheless, the Renaissance split the Catholic Church itself. Ironically, much of the Renaissance was financed by the Catholic Church and initially supported by priests, especially in Italy. Many of these priests would eventually be accused of blasphemy and excommunicated by the Catholic Church. It was very much a mixed bag for the Catholic Church. However, the Renaissance also found renewed interest in the Neoplatonists and Christianity. It was again marked by a rising interest in ancient Greece and was the origin of humanism and secularism. Humanism was marked by high interest in religious and philosophical traditions from all over the world.

Humanism sparked extensive inquiry into art, architecture, philosophy, literature, music. Secularism sparked more interest in science and technology and many other aspects of intellectual inquiry including physics.

Philosophers consider modernity to have started with René Descartes (1596-1650) in the early 17th century. Enlightenment is considered to be from the 17th century to the beginning of the 19th century. However, its effects still linger today. In my previous post entitled "George Orwell and Emmanuel Levinas Introspective: Socialism and the Other" [79], I dealt with the Age of Enlightenment which also started in the 17th century. At this point I would like to explore more of the philosophies of this period and how they pertain to quantum physics, which had its earliest beginnings in the 19th century.

In the 17th century Descartes doubted everything which could be doubted and discovered that what he could not doubt was that 'I think'. For Descartes this was the starting point which led from 'I think' to 'I exist'. This transition gave Descartes an ontological (*ontos* + *logos* or the study of Being, [80] existence, etc. whereas *ontic* refers to a particular being or existent) basis for the 'I' as a thinking substance. The Renaissance started winding down at the beginning of the 17th century, but its influence continued for centuries later. In the 17th century, Sir Isaac Newton (1643-1727) and Gottfried Leibniz (1646-1716) practiced and wrote admiringly about alchemy and the monotheistic God of Christianity. Alchemy was explicitly about changing base metals into 'higher' metals like gold with the philosopher's stone. Implicitly it was associated with the transmutation (or better trans-substitution) of wine into the blood of Jesus and the transmutation of God into man and man into God. It was the transformation of the impure into the pure and even, interestingly enough, vice versa.

We can also appreciate the alchemists' fascination with the symbolism of the mass, the cornerstone of the temple being metaphorically identical with the transubstantiation of bread and

wine into the body and blood of Jesus Christ. This fascination led to what is sometimes called Grail alchemy: the Grail became identified with the white stone in the Book of Revelation, and Wolfram von Eschenbach called it the lapis *ex caelis* [the stone from the heavens]. The philosopher's stone became known as the Food of Angels, and... the Tree of Life.

> Meanwhile, because the Word of God was transmitted by a chain of prophets, biblical images took on a historical and typological dimension. The mist from the earth in Eden returned as the water of life or living fountains of waters in the New Jerusalem. The fiery furnace of Daniel harkened back to the iron furnace of Egypt, a furnace of affliction out of which God chose his people, but it also looked forward to the day of reckoning when God promised to save his people: I will bring the third part through the fire, and will refine them as silver is refined, and will try them as gold is tried. Malachi predicted the Son of Righteousness would come as a refiner and purifier, which led the alchemist Paracelsus[81] to think he would be a master alchemist. This refiner would fix what Isaiah and the alchemists termed the flying serpent. The precious stones of Eden could then be reproduced for the walls of the heavenly city. The covering cherub covered in gems, who guarded the gates of Paradise, would meet his match in the angels of the apocalypse, who would be clothed (as the earliest Vulgate manuscript said) in white stone.[82]

One alchemist in the 17th century announced to the world that he had found the philosopher's stone.

> A more happy side effect of the quest for the elusive stone was the accidental discovery of phosphorus, first made by boiling copious amounts of human pee. In 1669, a German hobby alchemist named Hennig Brand got his hands on a

recipe for turning lead into gold using concentrated urine.

Brand somehow gathered more than 50 buckets of the golden liquid (he reportedly preferred the urine of beer drinkers), and after a likely gruesome period of experimentation in his basement laboratory, wound up with a bright, white liquid that would burst into flame when exposed to oxygen. Brand was certain he had found the philosopher's stone. In fact, he had discovered the 15th element on the periodic table, still used in the tips of matches today. He named it phosphorus, meaning "bringer of light." [83]

You can't make this stuff up! It pours freely from the Holy Grail of history!

Nearing the end of the 17th century, King of England had a minister who founded the Royal Society of England. At this time alchemy was widely practiced by members of the Royal Society. However, the King of England had a problem with it - it made people think the wealth of England came from magic practice and not the glory of the King.

The Académie had been founded in 1666 by Louis XIV's minister, Jean-Baptiste Colbert. Colbert prohibited two topics of study at the founding: astrology and the Philosophers' Stone. Both of these were potentially subversive. Astrological prognostications—forecasts about the king's health or coming war or famine—could threaten political stability. Making gold, or the possibility of making gold, could threaten economic stability. "The King does not wish it to be thought that his money is produced by goldmaking," wrote a visiting Swedish chemist in 1692.

So there was a real fear that alchemy, or rumors of alchemy, could undermine the state. People might think, writes Principe, that "Louis XIV's might and glory came not

from military prowess or wise governance but rather from chemical labors in smoky laboratories.” 84

Over time what we think of as chemistry started to split off from alchemy in the Royal Society. However, what actually happened for hundreds of years is that alchemy went underground, practiced by Royal Society members much longer in secret even after the Royal Society officially prohibited its practice.

Additionally, there was simply bad odor about alchemists. On one hand, they were often figures of comedy, “ridiculed in literature, on the stage, and in the visual arts.” On the other, they had a more sinister taint, “associated with poisoners, counterfeiters, frauds.” When a trio of young royals all died between 1711 and 1712, the nearest alchemist was blamed: the Duc d’Orléans’s tutor, Wilhelm Homberg, narrowly escaped being Bastilled. (Before Homberg died in 1715, he was trying to turn mercury into silver “using an oil distilled from human feces.”)

Despite the official prohibition, metallic transmutation efforts continued underground in the Académie. In fact, they went on at least until the 1770s, “long after the widely accepted dates for the ‘demise of alchemy’ in learned circles.” It certainly continued after Étienne-François Geoffroy’s 1722 landmark paper, “Des supercheries concernant la pierre philosophale” (“Some Cheats Concerning the Philosophers’ Stone”), “most frequently cited by historians as marking the end of ‘alchemy’.”

Principe calls Geoffroy’s paper, notably read in public, “primarily an act of public relations.” It was a “statement of the Académie’s official views” and “a tacit renunciation of the work Geoffroy and his master Homberg had performed previously.” Nothing published by the Académie afterwards even suggested the possibility of transmutation. But

> Geoffroy's own renunciation wasn't complete: he was still "involved in the problem of chrysopoeia" afterwards.
>
> A new divide arose between les vrais chemistes and les alchimistes, even though the former often had the latter as their teachers. The persistence of alchemical explorations might best be represented by Académie chemist Pierre-Joseph Macquer, who wrote: "Can one consider insane the person who labors for the Philosophers' Stone only for the pleasure of resolving one of the most beautiful and most difficult problems in natural philosophy?" 85

In alchemy, Christianity, spiritualism, science, and philosophy were all mixed together. Today, we think of this as a toxic mixture but two of the greatest minds in science and philosophy would disagree. In the early 18th century, Leibniz along with Isaac Newton were contributing greatly to modern calculus and physics. Leibniz articulated a rather ingenious philosophy which broke with his contemporary Descartes. Leibniz thought that you could never get to the smallest substance like an atom. Leibniz saw an infinite world of universes in every composite part which could be perceived.

> The least corpuscle is actually subdivided in infinitum and contains a world of other creatures which would be wanting in the universe if that corpuscle were an atom, that is, a body of one entire piece without subdivision. 86

Leibniz had lots of ideas about God, but all ideas resided in a single monad which could never have an externality to itself as that idea would still reside in the 'subject', the monad. All reality was composed of an infinite number of monads.

> There is no way of explaining how a monad can be altered or changed internally by some other creature, since one cannot transpose anything in it, nor can one conceive of any internal

> motion that can be excited, directed, augmented, or diminished within it, as can be done in composites, where there can be change among the parts. The monads have no windows through which something can enter or leave. Accidents cannot be detached, nor can they go about outside of substances, as the sensible species of the Scholastics once did. Thus, neither substance nor accident can enter a monad from without. 87

Leibniz's view was that 'all predicates are in the subject'. So, what was this 'subject' in which all 'perceptions' reside? For Leibniz, the subject for which all predicates exist exclusively was the monad. The idea of Leibniz that 'all predicates are in the subject', stated as—absolutely everything is composed of monads—which were infinite and had no exterior to themselves, played a significant role in later Western philosophy as we shall see.

Leibniz criticized the atomists who thought there was nothing smaller than an atom. What were these monads?

> In his most mature works, Leibniz suggests that at the deepest level of ontology, **we find only simple, mind-like substances,** or "monads." Although strictly indivisible, Leibniz insists that monads can nonetheless be thought of as unities of form, insofar as they are active, and matter, insofar as they are passive. According to this metaphysics, the gross bodies studied by physicists are at least twice removed from monadic reality. Gross bodies are grounded in organisms, or "corporeal substances," while corporeal substances are themselves grounded in simple substances, or "monads." This same chain of ontological dependence, however, likewise holds for forces: the active forces attributed to gross bodies are "well-founded" in the active forces attributable to organisms, which are "well-founded" in the active forces of monads, just as the passive forces attributable to gross bodies

> are “well-founded” in the passive forces attributable to organisms, which in turn are “well-founded” in the passive forces of monads. A full understanding of these grounding relations would of course require a more detailed explication of the relations between monads, corporeal substances, and gross bodies, as well as a fuller account of what “grounding” amounts to in this context. Nonetheless, even this rough sketch should suffice to indicate the broad outlines of Leibniz’s commitment to founding the active and passive forces he postulates as part of his physics in the most fundamental level of reality which he postulates as part of his most mature metaphysics. [88]

Leibniz is against materialism. He thinks perception is all that can form a unity. Matter is divisible and cannot be a true unity. Hence, materialism is false.

> If perception (and hence, consciousness) essentially involves a representation of a variety of content in a simple, indivisible “I,” then we may construct Leibniz’s argument against materialism as follows: Materialism holds that matter can explain (is identical with, can give rise to) perception. A perception is a state whereby a variety of content is represented in a true unity. Thus, whatever is not a true unity cannot give rise to perception. Whatever is divisible is not a true unity. Matter is infinitely divisible. Hence, matter cannot form a true unity. Hence, matter cannot explain (be identical with, give rise to) perception. If matter cannot explain (be identical to, give rise to) perception, then materialism is false. Hence, materialism is false. [89]

Material always shows itself as a unity of perception. Again, we come back to ‘all predicates are in the subject’. If beings are merely aggregations or additions of matter that will not add up to unities of

perception. If consciousness recognizes unity, it must be a different kind of substance than bodies.

> I believe that where there are only beings through aggregation, there will not even be real beings. For every being through aggregation presupposes beings endowed with a true unity, because it obtains its reality from nowhere but that of its constituents, so that it will have no reality at all if each constituent being is still an entity through aggregation; or else, one must yet seek another basis to its reality, which in this way, if one must constantly go on searching, can never be found
>
> …
>
> If there are aggregates of substances, there must also be genuine substances from which all the aggregates result. One must therefore necessarily arrive either at mathematical points from which certain authors make up extension, or at Epicurus' and M. Cordemoy's atoms (which you, like me, dismiss), or else one must acknowledge that no reality can be found in bodies, or finally one must recognize certain substances in them that possess a true unity. 90

So, what was 'matter' for Leibniz? Did Leibniz see the mind and matter as a duality? Was the mind as the unity of form an illusion composed of the body which was matter composed of atoms?

> For present purposes, we may think of materialism as the view that everything that exists is material (or physical) with this view closely allied to another, namely, that mental states and processes are either identical to, or realized by, physical states and processes. Leibniz remained opposed to materialism throughout his career, particularly as it figured in the writings of Epicurus and Hobbes. The realms of the mental and the physical, for Leibniz, form two distinct

realms—but not in a way conducive to dualism or the view that there exists both thinking substance and extended substance. By opposing both materialism and dualism, Leibniz carved himself an interesting place in the history of views concerning the relationship between thought and matter…

Leibniz's rejection of materialist conceptions of the mind was coupled with a strong opposition to dualistic views concerning the relationship between mind and body, particularly the substance dualism that figured in the philosophy of Descartes and his followers. According to this dualism, the world fundamentally consists of two disparate substances: extended material substance (body) and unextended thinking substance (mind). This bifurcation, of course, carries no burden of holding that the operations of the mental are realized by the operations of the physical. But despite his claim that consciousness and perception cannot be realized by, nor reduced to, the mechanical operations of matter, Leibniz found the alternative of postulating two distinct kinds of substance equally implausible…

Leibniz's opposition to Cartesian dualism stems not from a rejection of unextended substance, but from his denial of the existence of genuine extended material substance. To begin with, Leibniz held the Scholastic thesis that "being" and "one" are equivalent. He writes to Arnauld: "To be brief, I hold as axiomatic the identical proposition which varies only in emphasis: that what is not truly one being is not truly one being either". For Leibniz, in order for something to count as a real being—a substance—it must be "truly one," an entity endowed with genuine unity. And, as we saw above, in order for something to be a genuine unity, it must be a simple, indivisible entity. "Substantial unity," he writes, "requires a complete, indivisible and naturally indestructible entity". But matter is extended, and thus, Leibniz believes,

> infinitely divisible. Hence, there is no such thing, for Leibniz, as material substance. [91]

Leibniz' view that 'all predicates are in the subject' assumes that any possible thought must pertain exclusively to what thinks the thought - the subject. Even if I say that "I do not think", it can only be said by thinking it and so becomes just another proof of the 'I' that thinks. This logic is also inclusive of any metaphysical claim that there are some ideas that cannot be thought of at all. For example, the thought of God as what cannot be known is merely yet another idea of a subject which thinks it. Leibniz tells us that this makes the "I think" quite different from an ontological proof of existence. Eventually in history thinking makes the existing body the vehicle for the thinker. In doing this it modifies 'I think' into the binary duality of the thinking/thing or mind/body. However, Leibniz tells us that there is something quite different about Descartes' 'I think' and inundated in the 'body substance' and eventually the thinking/thing duality. 'I think' has a unity which no multiplicity of things added together would accomplish. Think about Victor Frankenstein making his creature which was referred to as 'being' out of various body parts and then somehow magically, vis-à-vis lightning, making 'Frankenstein', the creature, a thinking/ thing. There actually was a popular scientific theory at the time Mary Shelley wrote what she entitled "Frankenstein; or, The Modern Prometheus" called 'galvanism' which suggested that dead tissue could be reanimated with electricity. For Leibniz, mechanics cannot add up to the unity of perception which we call thinking.

> Leibniz's critique of Descartes and his followers was focused principally on the Cartesian account of body or corporeal substance. According to Descartes, the essence of body is extension; that is, a corporeal substance is simply a geometric object made concrete, an object that has size and shape and is in motion. This view, indeed, is the cornerstone

> of the new mechanical philosophy to which Leibniz was originally attracted. Nevertheless, Leibniz came to see two distinct problems with this view. First, in claiming that the essence of body is extension, Descartes is endorsing the view that matter is infinitely divisible. But if matter is infinitely divisible, then one can never arrive at the simple unities that must exist at some ontological ground level. Second, if matter is simply extension, then there is in its nature no source of activity. If this is so, Leibniz thought, then the bodily objects of the world cannot count as substances. [92]

Any possible thought must pertain exclusively to something other than materialism, an infinite chain of mechanical assemblages, which are not of the order of the unity of thought as form (referring implicitly to Plato's Forms). The problem of thinking returns as an ongoing theme in the history of philosophy from archaic mystic religions to ancient Greece to the world-souls of Neoplatonism. For Leibniz, what thinks the thought resides as a unity of perception which is of a different kind altogether than materialism. Thinking cannot get outside itself even in the denial of itself it affirms itself. This is inclusive of any positive metaphysical claim or even any claim of an idea that cannot be thought of at all.

George Berkeley (1685 - 1753), a contemporary of Leibniz, believed that 'mind' was all that exists. As discussed, for Leibniz the subject of all predicates must ultimately reside in the monad, the idea that 'all predicates are in the subject' is an immensely powerful idea which sustained itself through Western history. This was elaborated on particularly well in the German idealist G. W. Hegel (1770 - 1831) with a peculiar variation. Even now, there are still many thriving schools of Hegelians in professional philosophy. I want to preface the following with the note that I am not well read in Hegel, but it seems to me that all these Hegelian schools of thought seem to reflect to some degree Leibniz' view that 'all predicates are in the subject'.

Hegel was much more ingenious in his ‘dialectics’ which did not result in merely a thinking subject. I am not going to give detailed specifics on what follows concerning Hegel’s path where all predications lead us. I just want to convey how Leibniz's predicate within the subject can be transformed into a kind of Leibnizian subject as ‘Idea’. Importantly, ‘Idea’ here starts in dialectic or conversation with how the subject’s predications work themselves out. Hegel traces ideas through a hierarchy of assertions which cannot maintain itself against negations. These negations spring logically from the assertions themselves. These ‘organic’ oppositions are transformed into subsequent higher and higher levels of what Hegel thinks are more concrete transformations. These transformations maintain the polarities of the lower assertions but also find a more concrete idea which unifies them. Hegel ultimately finds the “unity of form” in Concept, not in a thinking subject or monads. Hegel’s approach is really incredible in the way he arrives at Concept. If I were to put it simply in a way that Hegelians would probably hate, I would say Hegel, before the reader’s eyes, creates a kind of non-metaphysical transubstantiation of base metal, body, and blood, into Concept. Concept leaves any such notion as concepts thought by a thinking subject to Concept, rising organically above being and Being to pure Concept. When ‘Pure Concept” negates itself, Hegel leads us dialectically into how Concept forgetting itself gives rise to space, then time. Additionally, for Concept to acquire the status of ‘absolute’, it must ontologically be all which must include its absence, forgetting itself, and its ontological presence. In this way Concept can emerge from its ontological status to pure epistemic truth. It is really quite impressive. For me, if Hegelians thought of it as a kind of work of art, I would agree with them. However, there certainly are schools of Hegel which take all these dialectical steps as immanent, meaning they do not think of it as metaphysics.

In this quote from Hegel’s “Science of Logic” Hegel acknowledges Leibniz’s insight into ‘all predicates are in the subject’

which Hegel calls the "*principle of reflection-into-self*". Hegel tells us otherness and external influence are correctly removed from the monad. He credits Leibniz for recognizing the "unity of form" which is of another kind than the objects of perception. However, he faults Leibniz for stopping short in "dogmatic reflection". Leibniz failed in recognizing the "*nature of reflection as the self-relating negativity which repels itself from itself whereby it posits and creates'*. Hegel writes,

> Clearly, by the principle of reflection-into-self which constitutes the fundamental determination of the monad, otherness and external influence in general are no doubt removed and the alterations of the monad are its own positing; but on the other side, passivity in relation to otherness has merely been transformed into an absolute limitation, into a limitation of the being-in-self or the in-itself. Leibniz ascribes to the monads a certain internal completeness, a kind of self-subsistence; they are created beings. When their limitation is considered more closely, it is evident from this account of the monads that the manifestation of themselves which belongs to them is the totality of form. It is an extremely important concept that the alterations of the monads are conceived of as actions in which passivity plays no part, as manifestations of themselves, and that the principle of reflection-into-self or of individuation stands out as essential. Further, it is necessary to let finitude consist in this, that the content or substance is distinct from the form, and also that the former is limited but the latter infinite. But now we should have to find in the concept of the absolute monad not only that absolute unity of form and content, but also the nature of reflection as the self-relating negativity which repels itself from itself whereby it posits and creates. True, in Leibniz's system, the further point is likewise to be found that God is the source of

existence and of the essence of the monads, which is to say, that those absolute limitations in the being-in-self or the in-itself of the monads are not limitations in and for themselves, but vanish in the absolute. But in these determinations are to be seen only the usual conceptions which are not philosophically developed, nor raised into speculative Notions. Thus, the principle of individuation does not receive its profounder realisation; the concepts concerning the distinction between the various finite monads and their relation to their absolute do not originate out of this being itself, or not in an absolute manner, but are the product of ratiocinative, dogmatic reflection and therefore have not achieved an inner coherence. 93

Hegel believed that Descartes was the starting point of his philosophy. Hegel further writes,

Descartes expresses the fact that we must begin from thought as such alone, by saying that we must doubt everything (De omnibus dubitandum est); and that is an absolute beginning. He thus makes the abolition of all determinations the first condition of Philosophy. This first proposition has not, however, the same signification as Scepticism, which sets before it no other aim than doubt itself, and requires that we should remain in this indecision of mind, an indecision wherein mind finds its freedom. It rather signifies that we should renounce all prepossessions — that is, all hypotheses which are accepted as true in their immediacy — and commence from thought, so that from it we should in the first place attain to some fixed and settled basis, and make a true beginning. In Scepticism this is not the case for with the sceptics doubt is the end at which they rest. But the doubting of Descartes, his making no hypotheses, because nothing is fixed or secure, does not occur in the interests of freedom as

such, in order that nothing should have value except freedom itself, and nothing exist in the quality of an external objective. To him everything is unstable indeed, in so far as the Ego can abstract from it or can think, for pure thought is abstraction from everything. But in consciousness the end is predominant, and it is to arrive at something fixed and objective — and not the moment of subjectivity, or the fact of being set forth, known and proved by me. Yet this last comes along with the other, for it is from the starting point of my thought that I would attain my object; the impulse of freedom is thus likewise fundamental. 94

In the following quote Hegel tells us how Descartes translates thought into existence.

Thought consequently comes first; the next determination arrived at, in direct connection with it, is the determination of Being. The 'I think' directly involves my Being; this, says Descartes, is the absolute basis of all Philosophy. The determination of Being is in my 'I'; this connection is itself the first matter. Thought as Being and Being as thought — that is my certainty, 'I'; in the celebrated Cogito, ergo sum we thus have Thought and Being inseparably bound together.

On the one hand this proposition is regarded as a syllogism: from thought Being is deduced. Kant more especially has objected to this that Being is not contained in thinking, that it is different from thinking. This is true, but they are still inseparable, or constitute an identity; their difference is not to the prejudice of their unity. 95

Hegel has told us in the quote above that we should not understand Descartes as merely telling us that logic is what proves *cogito, ergo sum*, I think, therefore I am. Hegel believes that thought and Being 96 are different but together they constitute a unity, an

identity. “Thought and Being” are different but not in a way that affects their identity. Put another way, ontology and thought form identity itself from which logic flows. Furthermore, Hegel tells us that for Kant “Thought and Being” are not identical due to their difference. Below, Hegel further explains what he thinks Kant’s error was,

> It would seem, then, as if critical idealism consisted in nothing but the formal knowledge that the subject and the things or the non-Ego exist each for itself – the Ego of the I think, and the thing-in-itself. They do not, however, exist for themselves in the sense of each being a substance, one posited as soul-thing, the other as objective thing. Rather, the Ego of the I think is absolute qua subject, just as the thing in itself beyond the subject is absolute, without any further categorical determinateness in either case. Objective determinateness and its forms first come in with the connection between them [the Ego and thing-in-itself]; and this identity of theirs is the formal one that appears as causal nexus; the thing in itself becomes object insofar as it obtains from the active subject some determination which for this reason alone is one and the same in both of them. Apart from this they are completely heterogeneous, identical only as sun and stone are in respect to warmth when the sun warms the stone. The absolute identity of the subject and the object has passed into this formal identity, and transcendental idealism into this formal or more properly, psychological idealism. 97

Hegel believes Kant ends in a subject-object dualism with “Ego of the I think” and the “thing-in-itself”. Hegel thought Kant stopped short of investigating the subject of Leibniz’ predicates. Leibniz’ subject cannot end in an eternal subjectivity whose negation is objectivity. From my previous discussion, this dualism would violate the indivisible nature of Leibniz’ unity of thought in Form.

This is where I think Hegel finds that Leibniz' subject must naturally and immanently arise from Concept. So, while Hegel's unity of apperception leads to Concept, Leibniz' unity of all predicates in the subject leads to the monad.

It may be that Hegel's point has much to do with how Enlightenment was transformed through Kant to an absolute subjectivity in which the thing-in-itself forever sealed subjectivity into solipsism. Perhaps better for purpose of this book, the thing-in-itself founds the absolute individual which capitalizes, originates, and founds an economy of transactionalism between thinking/ things. If nothing could be known of the thing-in-itself, there would be no place for values or beliefs in anything other than pure self-interest. I think that in one way or another people's common-sense thinking reflects this kind of self-orienting reference as a by-product of how these ideas filtered down over time into structural ways we perceive the world, as common-sense. Capitalism capitalizes on self-interest according to Adam Smith. This can only happen in a context in which the 'I' is assumed as absolute whose identity depends on nothing other than itself. I do not think this philosophy can be contradicted in its own terms. This resulting historic commonsense logic condemns the existential plight of 'human being' to a Sartrean "No Exit" of thinking, the thing-in-itself...except perhaps by choice - more on that later. Here, in 20th century physics, we have been brought to the precipice where our words, our certainties, our commonsense fails us.

What we think of as science had its roots in ancient mythologies, religion, and metaphysics. In the Roman period monotheism congealed into absolute certainty from Christian metaphysics. The idea of error was relegated to pagans. However, over the course of time alchemy tried its best to base its pseudoscientific theories on absolute certainty. Over time the alchemists discovered something odd, the notion of repeatability did not reflect absolute certainty. From the conflict of the Royal Society and alchemy over centuries a notion of science and statistical certainty developed into an idea of

probability and eventually a margin of error. However, underlying notions of error were ideas of absolute space and time. Even until Einstein in the early 20th century the idea of aether was still popular in science. The point is there have been dominant narrative strains of certainty adapted through history in a way that was compatible with statistical certainty. However, absolutes still found in 19th and 20th century positivist notions doggedly maintained objectivity as empirical 'laws of nature'. Even now commonsense still holds these truths to be self-evident as the inheritance of these traditions. The classical notion of objectivity is simply accepted as 'the way it is'. I will refer specifically to absolute certainty as the progeny of Western histories and traditions.

A Summation of General Comments

Quantum physics is uncomfortable. If we want to learn more about it, we will have to initially be willing to let go of our ingrained expectations of readily understandable ideas or at least, we must be willing to let go of the expectation of easily accessible notions from the start of the journey. Think about it sort of like a mystery novel where initially you just have to look at certain results which do not make any sense (who dunn-it). The difference is that instead of resolving the mystery over the course of the investigative journey, the mystery will only deepen in some quite amazing and beautiful ways. It is a journey that will take us away from our comfort zone but if we persist will fill us with a sense of awe, wonder, beauty, and more as we will see.

This book will attempt to show some interesting correlations between physics and philosophy over time and some of the ways they intertwine together, gathering their content. Both, in their own ways, try to prove their assumptions and clarify their intuitions. Certainly, nothing is ever absolutely proven in either, but they try to portend a certain amount of peer reviewed acceptance and synergy about each one's perspective fields. In physics and philosophy there is an incessant peer review process which would well be a vast book on each one of the topics and studies posted

below. I am not going to delve in depth into academic reviewer's questions and objections in these fields of research. At times, I will try to the best of my ability to give an indication of my reading of the acceptance and synergy around the applications or studies in these fields.

This is not intended to be an academic book. I want to try to present some astounding contemporary synergies between physics and philosophy. I find these synergies to be astounding to the point of demanding our concerted effort in addressing current societal threats. The current debates in these fields of study critically address us personally and enormous societal challenges which I plan to discuss. My intent, to the best of my ability, is not to simply provide evidence of negative effects of oncoming sociopolitical voids or proclaiming the overturning of dysfunctional social structures but to bring out avenues towards a more positive response to these oncoming irrevocable fractures. We are inevitably coming face to face with a vast chaos, an unbridgeable fracture, which threatens our very survival on this planet.

This book will have a more expansive review of physics than I originally intended. I found that the more educated I became about my initial concerns in physics, the more I had to learn about the history of physics and the complexities of current physics. I feel like it would not be fair to the readers to deprive them of the background material of my major theses. All this can be quite bewildering, but I did not want to make general, baseless claims to the best of my abilities. However, I do want to try to present the material simple enough for non-academics. This is a hard balance to maintain, and I am sure I did not always get it right. I have provided many quotes from many sources because I wanted to offer some checks for the reader to measure the inferences I have drawn from the material. There will be some sections that start with the text "A Deeper Dive" which will be a little more technical.

There are many mathematical functions which describe quantum relations for specific situations. Working physicists require

a large amount of highly specialized math. While I did have a lot of math and physics in my Electrical Engineering degree, I do not understand much of quantum physics' math. I have noticed a tendency for some writers about physics to go into great detail about mathematics. Certainly, this is a requirement for practitioners of physics and philosophers of physics. Many of the articles I have researched intermingle math with more understandable ideas that can be derived from math and experimentation. I understand that math brings a much higher amount of clarity to these subjects. However, most academics publish their findings in specialized, subscription only journals where they get peer reviews. While I do have and use several specialized subscriptions, for most of the rest of us, online magazines and videos have more understandable information about the spectacular findings in current physics and philosophy. Certainly, the more background in these areas the better.

My life-long academic interests and working background in electrical engineering and interests in physics over the years led me to recognize that newer findings in physics can no longer be distinct from philosophy. Both disciplines are coming together in amazing ways. My purpose here is to bring out the relevant ideas for readers who do not have a technical background. I understand that this kind of writing glosses over and even over-simplifies the subject which in some cases can be weak and inappropriate to the point of just being taken wrong in some cases. However, ultimately, I am trying to bring out highly relevant findings in philosophy and physics.

These findings have practical consequences on how we orient ourselves in reality. Current social and political upheavals are signs that we are undergoing epoch or age changing consequences related to these findings. The impact of these discoveries was understood by Albert Einstein (1879-1955), Niels Bohr (1885-1962), Werner Heisenberg (1901-1976), Erwin Schrödinger (1887-1961), and many others since then. However, due to the necessary

conservatism of academia many of these great thinkers had to find ways to soft-pedal the ramifications of their findings. Personally, I think this is done at the cost of enabling destructive narratives built on anachronisms like mechanistic metaphysics which have calcified in 'common-sense'. In protecting the rigors of science and philosophy, we have also introduced regressive and reactionary impediments to addressing different challenges and far-reaching possibilities which physicists and philosophers have been aware of for over one hundred years.

After looking at 20th century physics and philosophy in more detail, I want to turn my attention to the philosophy of Emmanuel Levinas to see how loosening physics' death grip on classical science with its cultural determinations can give us fresh new vistas towards a very different externality in philosophy which impacts each one of us directly. Since this material is difficult to understand, I will employ a repetitive, pedagogical technique in this book which I hope will bring more clarity. I will also intermingle the discussions of physics with philosophy. This may help make associations that the reader will find useful.

A Brief History and Explanation of Quantum Mind

First, let me state that quantum physics and mind or brain currently has a shaky relationship. Instinctively we understand that there must be some kind of relationship but we are a long way from understanding it. I am not a 'believer' but I think, for completeness this area needs to be investigated in this book. There is and has been a serious effort to bring consciousness into some form of quanta and physics but we are nowhere near a resolution of how consciousness, mind, and the brain works. You will be surprised in this book at the greatest and most well-respected physicists that have written extensively about and researched this area.

From the beginning of quantum mechanics starting with Einstein, discoveries have truly been startling and revolutionary. In

a little over a hundred years, established science and philosophy have been undermined and introduced an entirely different perspective than certain dominant historic views. The consequences of quantum mechanics cannot be understated. From early on leading physicists have been on the forefront of seriously contemplating far-reaching consequences of their discoveries. Many have also been serious philosophers, including Einstein. They have written and published books and articles on fundamental philosophical questions arising from quantum physics. Quantum physicists have led the way in entertaining unavoidable philosophical implications which are ramifications of their work. Over the decades the responses to these questions have ranged from serious philosophical works to a backlash on the part of some working physicists. Working physicists can be incentivized and in some cases necessarily required to keep their heads down. It can be dangerous for working physicists' careers to get too far ahead of academic consensus. It can also be dangerous for working physicists to entertain fringe questions ranging from religious, mystic, eastern philosophies, and highly speculative questions which physics is not prepared to answer yet in a definitive way.

Nevertheless, as we will see, many of the greatest physicists of the 20th century and even many lesser-known physicists have intriguingly ventured into these types of inevitable questions. I will try to explain how these questions arise from quantum physics and speculate about the scope and content where they may lead us. Again, physicists themselves have been at the forefront of initiating these questions. Foremost among these concerns are, how does quantum physics affect us personally? Quantum mechanics makes claims undermining almost every area of science including materials, chemistry, biology, astronomy, neurology, evolution, medical and research imaging, semiconductors and electronics, computing, and many others too numerous to mention. From the beginning, questions about our mind and consciousness have been and are being raised, researched, investigated, and taken seriously.

The reason for this is that it seems inevitable that these questions must be taken seriously. Quantum physics has had a long history of very serious and important physicists who have researched and produced numerous papers and books on the subject. If you want to get a better idea of what is involved check out: Consciousness and the Collapse of the Wave Function (.pdf). There are also many more references in "Appendix A (alpha) – Quantum Consciousness References".

As a general starting point, I want to point out differences between consciousness, subconsciousness, and unconsciousness. Consciousness refers to our awareness of the external world, our thoughts, feelings, and sensations. It's the state of being awake and perceiving our surroundings. Conscious processes are under our control. We intentionally direct our attention and make decisions. Conscious experiences are in the present moment. Our conscious mind can only hold a few pieces of information at once. Conscious examples are:

- our own thoughts and feelings
- solving a math problem
- reading this text
- deciding what to eat for lunch.

The subconscious mind operates below the level of conscious awareness. It's like an underground stream influencing our thoughts and behaviors. Subconscious processes occur without our deliberate effort. It stores recent memories and experiences. Unlike the unconscious, it's not seen as a separate consciousness. Subconscious examples are:

- riding a bike (once you've learned it)
- recalling a phone number
- experiencing déjà vu.

The unconscious mind is a reservoir of feelings, thoughts, urges, and memories that are outside of our conscious awareness. It hides extremely unpleasant memories or socially unacceptable desires. The unconscious operates autonomously and instinctually. Unconscious examples are:

- many defenses (like denial, projection) originating during childhood
- traumatic memories
- suppressed emotions
- unresolved conflicts reside here.

Consciousness is our active awareness, the subconscious operates automatically, and the unconscious conceals memories and emotions we may not consciously acknowledge. [98]

An important point on this matter is that consciousness, subconsciousness, and unconsciousness are not some kind of mind/body duality from historic philosophical narratives. All these functions are shorthand names for physical and likely quantum components in our brains and distributed through our bodies. Here are some biological associations for these components:

The ascending reticular activating system (ARAS) plays a pivotal role in consciousness. It consists of multiple anatomical and neurochemical components located in the rostral brainstem tegmentum, thalamus, and cortex. The ARAS is responsible for alertness, which is a prerequisite for maximal awareness. Sensations initially reach the cortex, where they are further selected and processed. Perception involves abstracting selected sensory information, allowing us to grasp a limited concept of the external world and our internal state. Attention directs and selects specific information while excluding others. Working memory transiently holds information for immediate action and decision-making. Certain forms of memory are accompanied by conscious awareness, providing a sense of continuity in daily life. Motivation involves

prioritizing and choosing behavior. The brain also possesses the capacity for self-awareness, recognizing cognitive and mental processes. [99] Subconscious functions involve neural networks that operate without our explicit attention. These processes include automatic bodily functions (e.g., heartbeat, digestion) and learned behaviors (e.g., riding a bike). Neural circuits in the basal ganglia, cerebellum, and other brain regions contribute to subconscious activities. Two critical neurological components maintain consciousness:

- Cerebral Cortex: The gray matter covering the outer layer of the brain is essential for conscious experience.
- Reticular Activating System (RAS): Located in the brainstem, the RAS regulates arousal and alertness. Disruptions in the RAS can lead to unconsciousness. [100]

Even more importantly, just as any physical system is not hermetically sealed off from everything else, the brain, or a better word 'mind', is highly interactive with its environment. Quanta and its spooky *phusis* underlie anything and everything and as we will see it is interactive to such extremes that it requires a very different approach than anything classicism could have anticipated.

It is not obvious why our mind cannot simply be an isolated classical system having no direct relationship to quantum mechanics. However, as we will see classical mechanics alone cannot fully explain levels of consciousness. Quantum-mechanical phenomena, such as entanglement and superposition, certainly play a role. These nonlocalized quantum effects might interact in smaller brain features than cells, influencing critical aspects of consciousness. Physicist Eugene Wigner (1902-1995) suggested that quantum mechanics is connected to the mind. He proposed that the wave function collapses due to its interaction with consciousness. Freeman Dyson (1923-2020) argued that "mind, as manifested by the capacity to make choices, is inherent in every electron."

However, contemporary physicists and philosophers have serious questions about this. Physicist David Bohm (1917-1992) viewed quantum theory and relativity as contradictory, implying a deeper level of reality. He formulated an implicate order theory, suggesting an undivided wholeness underlying matter and consciousness. Bohm believed that mind and matter project from this implicate order into our explicate order (the observable universe). Bohm discussed music experience, where movement and change arise from holding the immediate past and present together. Musical notes from the past are transformations, not mere memories. This perspective highlights the interplay of time and consciousness. Quantum computing is also giving us many insights into how our brains work. Comparative studies incorporate quantum physics concepts (entanglement, superposition, etc.) to understand the human brain. Investigating how commercial quantum devices may address unresolved brain areas. Quantum mind research bridges physics and consciousness, exploring the mysterious link between the quantum world and our awareness. 101

However, it is still very early to say how all this will play out. One thing for sure, it will not in any way be business as usual for the sciences, philosophy, and religion. Whatever the eventual findings are they will implicate all of us inclusive and most importantly what we casually assume as 'reality'. Stanford has an article on historic and current areas of research on quantum consciousness. The article states,

> It is widely accepted that consciousness or, more generally, mental activity is in some way correlated to the behavior of the material brain. Since quantum theory is the most fundamental theory of matter that is currently available, it is a legitimate question to ask whether quantum theory can help us to understand consciousness. 102

I will discuss these issues of quantum consciousness throughout

the book.

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1 After having made a lifetime of academic and personal pursuits in philosophy and science, I have concluded that what we think we know barely scratches the surface, almost to the point of absurdum, of what knowledge at its best has to teach us. I prefer the word wisdom to knowledge as that joins praxis with logos, practice with reason. We should all learn that there is a rest in knowing that we do not know joined with the pursuit of wisdom. I have no peer review or reviewers of any kind in philosophy or physics. Still, I love the pursuit of knowledge. I apply myself to the best of my abilities to learn. I have nothing to defend, no pride to protect, no insecurities to hide, no career to make. I do not consider myself smart. I feel very comfortable knowing that I do not fully understand the topics I write about. I simply do my best to try to learn, make my best attempt writing about what I learn, and translate what I learn into practical life. I have made many mistakes, but I have found that the life-long pursuit of doing better is an odd sort of redemption of the past. I love constructive criticism and consider it as a favor when I get it. It seems that it is always easy to just dismiss someone we do not agree with or think of them in some demeaning way. However, more extended, and open face to face encounters generally tend to disarm preconceptions and increase the complexities of the other. I look at writing as a community project and am always happy to collaborate, revise, and learn from anyone that has the time. One other note, I have proofed this monstrosity more times than I care to think about, but I know there are still editing mistakes as incorrect words which tend to get filled in automatically by Word and I do not catch. Any corrections I get are appreciated or *constructive* criticism.

2 Paraphrased from here: Narcissus and Echo

Also Narcissus

3 Emmanuel Levinas, *Otherwise than Being, or Beyond Essence*, trans. Alphonso Lingis (Pittsburgh: Duquesne University Press, 1998), 103.

4 See The Gaze of Orpheus

— Boethius, Consolation of Philosophy 3.52

5 See Ionian School (philosophy)

6 Introduction to Metaphysics, trans. G Fried and R Polt, 2 ed. (New Haven and London: Yale University Press, 2014), 15-16.

7 Introduction to Metaphysics, trans. G Fried and R Polt, 2 ed. (New Haven and London: Yale University Press,

2014), 15.

8 See Constantine I Roman emperor

And Constantine

And The reforms of Diocletian and Constantine

And Legacy of Constantine I

And Constantine the Great

9 See Maxentius

And Licinius

And Licinius (Wikipedia)

10 See Aristotle Metaphysics

The first major work in the history of philosophy to bear the title "Metaphysics" was the treatise by Aristotle that we have come to know by that name. But Aristotle himself did not use that title or even describe his field of study as 'metaphysics'; the name was evidently coined by the first century C.E. editor who assembled the treatise we know as Aristotle's Metaphysics out of various smaller selections of Aristotle's works. The title 'metaphysics'—literally, 'after the Physics'—very likely indicated the place the topics discussed therein were intended to occupy in the philosophical curriculum. They were to be studied after the treatises dealing with nature (ta phusika). In this entry, we discuss the ideas that are developed in Aristotle's treatise.

See Metaphysics

11 See Metaphysics (Aristotle)

And Metaphysics: Books Alpha to Epsilon

And The Origin of the Concept of Metaphysics

12 See Physis

13 "Discussion of Probability Relations Between Separated Systems" (1935)

14 See Einstein-Podolsky-Rosen

15 Maldacena, Juan. November 1, 2016. Entangled Wormholes Could Pave the Way for Quantum Gravity. Scientific American (online)

Also, Einstein's 1935 papers: EPR = ER?

And Einstein Versus the Physical Review

16 SCIENTIST OF THE DAY - NATHAN ROSEN

Albert Einstein and Nathan Rosen, Physical Review, vol. 48d, 1935; note the mention of a "bridge" in the abstract (Linda Hall Library)

17 SCIENTIST OF THE DAY - NATHAN ROSEN

18 See Can Quantum-Mechanical Description of Physical Reality Be Considered Complete?

Also, Einstein, A., Podolsky, B., and Rosen, N. (1935). Can quantum-mechanical

description of physical reality be considered complete? Physical review,

47(10):777.

Einstein, A; B Podolsky; N Rosen (1935-05-15). "Can Quantum-Mechanical Description of Physical Reality be Considered Complete?" (PDF). Physical Review. 47 (10): 777–780. Bibcode:1935PhRv...47..777E. doi:10.1103/PhysRev.47.777

19 See Physicists Create a Holographic Wormhole Using a Quantum Computer

20 See ER = EPR - Wikipedia

And General Relativistic Wormhole Connections from Planck-Scales and the ER = EPR Conjecture

21 See ER = EPR - Wikipedia

And General Relativistic Wormhole Connections from Planck-Scales and the ER = EPR Conjecture

22 See Kinetic and Potential Energy.

23 See What is a Photon?.

24 See Theogony

25 See Hesiod Theogony

26 See Hesiod Theogony

27 See Genesis (Perseus)

And Genesis (Wiktionary)

28 See Hesiod's Theogony

And Genetics

And Hesiod

29 See ἀρχή

30 See Genesis (Wiktionary)

31 See -genesis

32 See Chaos (Wiktionary)

And Chaos (Wikipedia)

And Chaos (cosmogony)

And Chaos Meaning and History

33 See The pace of evolution

And Speciation and Bursts of Evolution

And Evolution to the rescue: Species may adapt quickly to rapid environmental change, yeast study shows

And Evolutionary Change, Rate of

34 See A quantum physics layer of epigenetics: a hypothesis deduced from charge transfer and chirality-induced spin selectivity of DNA

35 See Nomos and Phusis

And Physis vs Physics: Similarities, Differences, and Proper Use

And What is the Greek meaning of phusis?

And Metaphysics vs. Physics (Difference Explained)

And Physis (Wikipedia)

36 See Physis (Wikipedia)

37 See AN INTRODUCTION TO PRE-SOCRATIC ETHICS: HERACLITUS AND DEMOCRITUS ON HUMAN NATURE AND CONDUCT (PART I: ON MOTION AND CHANGE)

And Heraclitus (Wikipedia)

And Archeo-Logos: Hegel and Heidegger on Finding the Principle in Heraclitus' Saying

38 See Science (n.)

And The weighty history and meaning behind the word 'science'

And Science (Wikipedia)

39 See To Be, or Not To Be

40 See Alterity

41 See Notes to Emmanuel Levinas from notes regarding Emmanuel Levinas

"An absolute transcendence has to be produced as not integratable into knowledge or intentional constitution". (TI: 53.) Subsequently he adds, "A relation with what…comes absolutely from itself is needed to make possible the consciousness of radical exteriority" (192). This is the relation with the other understood as she who speaks to me, or he whose regard has singled me out, before I ponder him as an empirical being. In 1984, Levinas goes so far as to say, "the notion of transcendence, of alterity, of absolute novelty" has a unique relation to knowledge which, beyond the 'fit'

between consciousness and its objects, “calls to another phenomenology, though it be the destruction of the phenomenology of appearing and knowledge.”, (1984, Transcendance et intelligibilité, Geneva: Éditions Labor et Fides: 17–18, my trans.) also the English translation: “Transcendence and Intelligibility”, in 1996, Emmanuel Levinas: Basic Philosophical Writings, Adriaan Peperzak, Simon Critchley, and Robert Bernasconi (eds.), Bloomington, IN: Indiana University Press..

42 See Nerve cell migration after birth may explain infant brain’s flexibility

And What are the most important changes in the brain after birth?

And How Do Neurons Fire? Understanding How Actions Potential Work

43 See Zarathustra's Prologue

44 See archē

And arche

45 See Logos

46 See 1 John 1

47 See Complementarity (physics) - Wikipedia

48 Paul A. M. Dirac, *The Principles of Quantum Mechanics*, 4th ed. (Oxford: Clarendon Press, 1958), 12. *(Note: The quote is from Chapter 1: "The Principle of Superposition,"*

49 See Quantum superposition - Wikipedia

50 See HERODOTUS

51 If I do not specify AD or BC, assume AD

52 See Theory of Forms

53 See morphē

54 See Rhizome

55 See Rhizome (philosophy)

And Rhizome (philosophy) 1

And Rhizome (philosophy) 2

And rhizome

56 See The Ancient World Homer and Hesiod - Princeton University

57 See ontology

58 See Relationship between religion and science

And The Role of Religion in the Scientific Revolution

And History of science

And Philosophy: Metaphysics and Philosophy of Religion

59 See alchemy

And The Roots of Chemistry: How the Ancient Tradition of Alchemy Influenced Modern Scientific Thought

And Outline of alchemy

60 See Plotinus, Life in Rome

61 See logos

62 See http://heraclitusfragments.com/B1/index.html

63 See http://heraclitusfragments.com/B2/index.html

64 See http://heraclitusfragments.com/B45/index.html

65 See http://heraclitusfragments.com/B72/index.html

66 See http://heraclitusfragments.com/B87/index.html

67 See http://heraclitusfragments.com/B108/index.html

68 See http://heraclitusfragments.com/B115/index.html

69 See https://philarchive.org/archive/JOHOLI-3

70 See http://heraclitusfragments.com/categories/logos.html

And http://heraclitusfragments.com/index.html

71 See DK B40, https://heraclitusfragments.com/files/ge.html

72 See DK B45, https://heraclitusfragments.com/files/ge.html

73 See DK B123, https://heraclitusfragments.com/files/ge.html

74 See DK B124, https://heraclitusfragments.com/files/ge.html

75 See DK B10, https://heraclitusfragments.com/files/ge.html

76 See DK B60, https://heraclitusfragments.com/files/ge.html

77 John Burnet's “EARLY GREEK PHILOSOPHY”

John Burnet, 3rd edition (1920). London: A & C Black

CHAPTER III., HERAKLEITOS OF EPHESOS

Note 15

78 See Rhizome in Philosophy

79 See George Orwell and Emmanuel Levinas Introspective: Socialism and the Other

80 When Being is meant on an ontological level I will capitalize it. No oracular status is meant by the capitalization. When being is ontic I will leave it in lower case.

81 See Paracelsus

82 See Alchemy and the Bible, page 123.

83 See The Eternal Quest for Aether, the Cosmic Stuff That Never Was

84 See When Did Alchemy End?

85 See When Did Alchemy End?

86 See Leibniz's Philosophy of Physics

87 See Leibniz's Philosophy of Mind

88 See Leibniz's Philosophy of Physics (Stanford Encyclopedia of Philosophy)

89 See Leibniz's Philosophy of Mind

90 See Leibniz's Philosophy of Mind

91 See Leibniz's Philosophy of Mind

92 See Gottfried Wilhelm Leibniz

93 See Hegel's Science of Logic, Section 1186

94 See Hegel's Lectures on the History of Philosophy, Section Two: Period of the Thinking Understanding, Chapter I. — The Metaphysics of the Understanding, A 1. DESCARTES.

95 See Hegel's Lectures on the History of Philosophy, Section Two: Period of the Thinking Understanding, Chapter I. — The Metaphysics of the Understanding, A 1. DESCARTES.

96 From henceforth, when Being is capitalized it designates the idea of Being not individual beings

97 See Hegel-by-HyperText - Faith and Knowledge A. Kantian Philosophy

98 See Subconscious vs. Unconscious: How to Tell the Difference

And The Unconscious And Subconscious: What's The Difference?

And The Conscious, Subconscious, And Unconscious Mind – How Does It All Work?

And Subconscious vs. Unconscious: What's the Difference?

And The Differences Between Your Conscious And Subconscious Mind

99 See Neurobiological Basis of Consciousness

100 See Disorders of consciousness

And Where Neuroscience Stands in Understanding Consciousness

And Neural correlates of consciousness

101 See Quantum mind

And Potential of quantum computing to effectively comprehend the complexity of brain

And Consciousness and the Quantum Mind

And How the five National Quantum Information Science Research Centers harness the quantum revolution

102 See Quantum Approaches to Consciousness

I

Phusis: Towards Radical Exteriority as Physics

In this section I want to explore some startling findings in quantum physics and how they dovetail with contemporaneous philosophical schools in the 20th century. Over the centuries in the West, historic religions from archaic traditions through ancient Greece through the congealing of monotheism and the world-soul of the Neoplatonism through Latin Christianity through alchemy to its breakup from the Royal Society at the end of the Renaissance and further into modernity, all of this history went silent in the minds of common folk, but their language and customs gave voice to this silence as simple common sense. All of these histories are not present to us as something sitting right in front of us of which we are aware. However, these histories filter down and inform our sense of practical 'reality' upon which we base our day-to-day judgements on. How this 'lived reality' works was the focus of 20th century phenomenology.

As a lived modality of how we are, phenomenology is not the domain of traditional science but comes into play interesting enough during the same period of Einstein's relativity. This will be discussed further down in more detail. For now, let's think about how classical physics has congealed into strong footholds in many people's perceptions of 'reality' and 'truth'. The ideas of an absolute God, absolute time and space, objectivity and subjectivity, mind and matter and many such notions already determine our day-to-day practicality. Classical ideas based on Newtonian ideas of absolute space and time were preceded by a long tradition from

Latin Christianity which had congealed from a monotheistic God. Previous traditions of animism and multiple gods indwelling through nature in time and space gave way to a single absolute God which existed eternally outside of time and space. It is interesting to note that very ancient notions of alchemy survived and thrived long after Latin Christianity. Alchemy preserved many of the ancient traditions in a hybrid environment of Christianity. However, over time, alchemy increasingly went underground at the behest of England's Royal Society which nevertheless maintained secret links within its society to alchemy. The last vestige of alchemy - aether, was abolished thanks to Einstein in the early 20th century.

The findings in the last 118 years of physics placed demands on 20th century philosophy. These findings symbiotically imposed strangely different ways of understanding ourselves. Namely, Einstein's relativity and his quantum physics budded from the framework of classical physics which, over the 18th century, provided Einstein with his start towards a novel departure from both religious and scientific absolutism. His start both retained a form of classical science, given certain assumptions, as a limited case of relativity. However, by expanding and undermining the scope of absolute space and time into relativity, the historic underpinnings of Newton and Christianity began to collapse. At the time, Einstein received much ridicule and vitriol from physicists and religious leaders.[1] Basically, the far-right Christians, anti-Semites, and Nazis accused Einstein of heresy, what we now call 'wokeism', because he made everything 'relative'.[2] In 1931, shortly before the Nazis came into power in Germany, a book was published entitled "One Hundred Authors Against Einstein" which included religious leaders and scientists in opposition to relativity. Einstein is reported to have said, "It would not have required one hundred authors to prove me wrong; one would have been enough."[3] Now Einstein's quantum physics has begun to loom before us striking at the very heart of religious certainty; what we deem as faith.

Quantum uncertainty can find no foothold in a traditional cosmos where God reigns supreme. At this moment in history, if faith is to meet what looms before us, it will have to face bizarre uncertainty. Secular society as well, which retains the mechanics of reality, has also been dealt a fatal blow. Kant's *a priori* categories must now be thought of as highly uncertain. Kant's Categories of Understanding as not thoughts themselves but are what makes thoughts possible.

> Kant responded to his predecessors by arguing against the Empiricists that the mind is not a blank slate that is written upon by the empirical world, and by rejecting the Rationalists' notion that pure, a priori knowledge of a mind-independent world was possible. Reason itself is structured with forms of experience and categories that give a phenomenal and logical structure to any possible object of empirical experience. These categories cannot be circumvented to get at a mind-independent world, but they are necessary for experience of spatio-temporal objects with their causal behavior and logical properties. These two theses constitute Kant's famous transcendental idealism and empirical realism.[4]

From Hegel on Kant's rational triumph over the empiricist's pure senses must ultimately fall to the spooky uncertainty which cannot be purely rational or pure sensibility but some murky bog in which the observer cannot be dismissed from the observed. Susskind writes,

> It is obvious that the Copenhagen Interpretation cannot be the last word. The universe is filled with subsystems, any one of which can play the role of observer. There is no place in the laws of quantum mechanics for wave function collapse; the only thing that happens is that the overall wave function

> evolves unitarily and becomes more and more entangled. The universe is an immensely complicated network of entangled subsystems, and only in some approximation can we single out a particular subsystem as THE OBSERVER.[5]

Neither can all this lapse into any historic notion of subjectivity as it falls between and exceeds the lines of subjectivity and objectivity. The universe has struck a perfect note in the strings of the multiverse which resound in the quantum wave function's movements of information updating. While you may have heard prematurely that string theory is dead, its math lives on and is most viable in current physics' work bringing together large scale 'gravity' with the other small scale quantum forces. Throughout classical history and its offspring modernity, science, philosophy, and religion have been knit together, albeit at times reluctantly like any marriage, to provide a common transactional basis for societies to thrive and violently conquer. This transactional practicality *is* what we know as common sense. The movement of history, its languages and cultures which diverge and converge, is toward common sense. Common sense defines the arena where practicality can take form. It does not do this overnight. It takes centuries of war, occupation as the detente of war, to set up a day-to-day narrative in which survival can more or less take shape in the form of a society. At the present day, philosophers and scientists have struck a fatal blow into the heart of classical history and its child, modernity. We have already seen the first failings in societies all over the world.

We see these failings in extreme reactionary and violent moves to return to fading narratives from the past which can no longer sustain themselves or bear up under the burden of alternate narratives. These alternate narratives of 'reality', of history, of existence do not come from without but from within. They are not simply "theories" or metaphysics which can easily be dismissed. Jacques Derrida states this dilemma as understated narratives

within the text of history which undermine the dominant narratives. However, even beyond that, these alternate narratives can no longer be seen as counter valences which always come from within the text. They represent a trace which the text finds difficult to put into easy words or even marginal words. We struggle to even think these thoughts not so much because they are difficult as they cannot find a home in our histories, our narratives, our texts. We are uncomfortable with their ambivalence. We want to rush to make them fit into common sense, but we now know they have no home there. Additionally, now with climate change and the threat of nuclear annihilation we have no time to take time, to let centuries of war and peace do their work. We are rushed to give an answer, but none seems to come.

I understand these iconoclastic shattering's of physics and philosophy to be imposing unconditional requirements on culture which we can react to with violence or alternatively, we can face the approaching void to see what new possibilities can be gleaned for our future. The hurdle here is that the older expectations of 'the answer' must remain forever contingent on uncertainty which does not grasp but which now must release and recognize responsibility. More on this later. For now, let's explore in detail how all this plays out in current physics.

BRANCHES OF PHYSICS

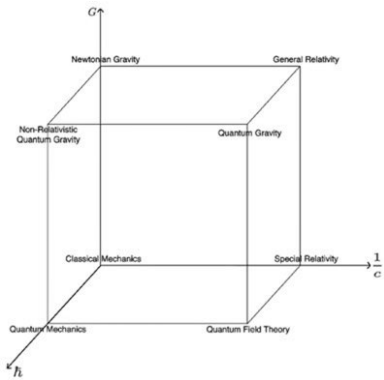
When we get to really small distances quantum mechanics becomes more important because some physical properties get quantized or become discrete. In this case the reduced Planck's constant 'h' has an ever oddly and quantized, recurrent appearance. When we include the higher speeds of special relativity and gravity, we get to Einstein's theory of general relativity. In this case the constant speed of light 'c' becomes important. When we arrive at the higher speeds of special relativity and small distances, quantum field theory will do the job. This is the case where Planck's constant 'h'

and the constant speed of light ‘c’ come to the fore. If we want to look at small distances and gravity, we will find ourselves in the terrain of non-relativistic quantum gravity. This is the case where Planck’s constant ‘h’ and the gravitational constant ‘G’ take center stage. The final stopping place is the higher speeds of special relativity, small distances, and gravity where we would be at in the domain of quantum gravity or the theory of everything. This is the all-inclusive case where Planck’s constant ‘h’, the constant speed of light ‘c’, and the gravitational constant ‘G’ all find their place in quantum gravity.

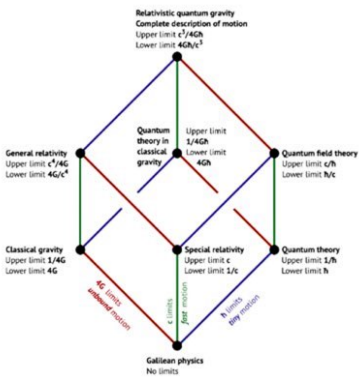
> Starting from classical mechanics, there are at least three interesting ways to extend the theory each of which introduces a constant of nature that is absent in classical mechanics: (1) at large velocities with respect to the velocity of light c the theory extends to special relativity; (2) at small distances certain physical quantities get quantized in units of the reduced Planck’s constant ħ[or h-bar] corresponding to quantum mechanics and (3) a gravitational force can be introduced via Newton’s constant G leading to Newtonian gravity. There are two well-known ways to combine two of these extensions: (1) extending classical mechanics with high velocities and gravity leads to general relativity and (2) extending classical mechanics to high velocities and small distances leads to quantum field theory. Logically speaking, however, there is a third way, namely extending classical mechanics to small distances and gravity. This would lead to a theory of non-relativistic (NR) quantum gravity. Finally, the maximal extension to high velocities, small distances and gravity leads to the long sought for theory of quantum gravity. [6]

The Bronstein cube is an effective way to show areas of studies in physics. Movement away from “Classic Mechanics” on the ‘G’

axis exhibits cases where gravity becomes more of an issue. Movement away from “Classic Mechanics” on the Planck constant ‘h’ axis indicates a direction toward smaller and smaller distances and mass. Movement away from “Classic Mechanics” on the ‘1/c’ axis indicates cases where the speed of light becomes an issue.



7



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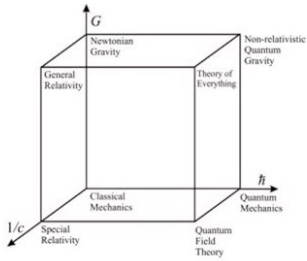


Bronstein Cubes

The Bronstein cube below gives a better picture of the limits where the various areas of physics become more important.

EINSTEIN'S RELATIVITY AND QUANTUM PHYSICS

Einstein's "miracle year" in 1905 came out in four different papers in a scientific journal called *Annalen der Physik* or "Annals of Physics". The papers were:

1. The first paper explained the photoelectric effect, which established the energy of the light quantum (the photon) and was the only specific discovery mentioned in the citation awarding Einstein the Nobel Prize in Physics.
2. The second paper explained Brownian motion which led reluctant physicists to accept the existence of atoms.
3. The third paper introduced Einstein's theory of special relativity, which established the universal constant speed of light (186,282 miles per second) for all reference frames and a theory of spacetime.
4. The fourth, a consequence of the theory of special relativity, developed the principle of mass-energy equivalence, expressed in the famous equation $e = mc^2$ and which led to the discovery and use of atomic energy.

Mass

There are two types of mass in physics: inertial mass and gravitational mass.

To start this discussion, let's just pretend that we are living in a classical universe where all space and time has no absolute speed limit at the speed of light. The classical physics' universe has no other accelerating referential frames relative to any other accelerating referential frames. In this classical universe objects themselves can still be accelerated. An object has weight. But weight is dependent on gravity. What we weigh in space is very different from what we weigh on the surface of the earth. What is the same about objects which do not depend on where we are in space?

As already stated, in the classical universe, it makes no sense to talk about a particular region of space as accelerating relative to any other region of space. This is another way of saying that our inertial frame is not accelerating. Inertial mass in this universe is consistent with Newton's second law of motion, which tells us that the mass of an object is a measure of its opposition to acceleration. Inertia is a body's resistance to acceleration.

One thing to take note of here, which is commonly confused, is the difference between inertia and momentum. As mentioned, inertia is the resistance of a body to changes in its velocity or acceleration. Momentum is the tendency of a body to remain in motion, like a freight train. If I throw a small rock in space, I will feel very little resistance. However, if I try to throw a comet, I will not only feel a lot of resistance due to its size, but something will push me back. Even though the comet weighs nothing as it is floating, it does not want to change its direction; it resists changing its direction because of inertia.

If I am in space and push a heavy box, it will float away at a slower speed. On the other hand, if I have a lighter small ball and push it with the same force I pushed the box, it will float away at a

much higher speed. Why? The heavier box resists my push more than the lighter ball because it has more mass. Light and heavy are terms we use in the presence of what we call gravity. The ‘heavier’ box here implies that the box has more mass and therefore more inertia, meaning it does not want to change its current motion more than the ‘lighter’ ball does. One form of inertial mass is called rest mass or invariant mass. Rest mass is the same no matter how fast an object is accelerated.

Gravitational mass is what determines the strength of the gravitational field generated by an object. The only difference between inertial mass and gravitational mass is how they are measured as far as we know. They have the same value.

> Inertial mass and gravitational mass of an object are identical in value, but differ in how they are measured. Inertial mass is measured by measuring an object's resistance to changes in velocity; while gravitational mass describes the force on an object in a gravitational field. [10]

Gravitational mass is broken down as passive and active gravitational mass. Passive mass is an object’s reaction to a gravitational field. Active mass describes gravitational forces created by an object.

> Gravitational mass describes how much a mass is affected by a gravitational field compared to masses of known value. Gravitational mass is determined by measuring passive mass, an object's reaction to a gravitational field. This is in contrast to active mass, which describes the gravitational forces created by an object. [11]

The strength of a gravitational field is not only determined by an object’s gravitational mass but also by all other objects generating gravitational mass in the gravitational field. More specifically,

gravitational fields are a result of spacetime curvature. When spacetime curves an object in motion, the object wants to follow that curvature unless another force acts upon the object.

Any object which has motion has translational motion and rotational motion. When an object moves it can have translational motion and rotational motion. Translation motion is movement in a single direction. Rotational motion is movement in an angular direction. If I throw a curve ball in baseball, the translational direction is towards the batter. The rotational motion is the spinning of the baseball. Note that in baseball the spinning of the baseball has an angular momentum or acceleration which can also change the translational direction of the baseball. This is called a curve ball. In mathematics this is represented as a three-dimensional vector field with translational and rotational forces adding and subtracting to get the result of the baseball's direction of motion.

In our Newtonian universe, the gravitational mass and the inertial mass is the same because the inertial frame is assumed to have no acceleration. This is called the weak equivalence principle. However, in a universe where the speed of light is an absolute limit something has to change to accommodate this requirement. What changes? In our universe where the speed of light matters, we can observe that the speed of light is a speed limit which changes space and time itself to accommodate this rather odd speed limit (e.g., relativity of simultaneity, length contraction, time dilation, etc. to be discussed later).

Speed is practically what determines the difference between mass and energy in Einstein's famous equation. Einstein's special relativity showed the connection with mass and energy in the famous equation.

Formula 1: $e = m_{rel}c^2$

where 'e' is energy, 'm' is relativistic mass, and 'c' is the speed of light (186,282 miles per second).

Another derivation of the formula includes momentum and rest

mass.

Formula 2: $e^2 = m^2_{rest}c^4 + p^2c^2$

Here ‘p’ is momentum and ‘m’ is rest mass.

These formulas are called mass-energy equivalence. [12] Anything which has mass has energy and anything which has energy traveling less than the speed of light has mass. Since ‘c’ is an exceptionally large number, you can see from these formulas that an incredibly large amount of energy is stored in mass. You can also see from these formulas that when an object loses energy it will also lose mass. The formulas also suggest that when an object has no momentum, the tendency for a body to stay in motion is equal to zero, then mass and energy only differ by the speed of light squared. The energy part of the mass-energy equivalence accounts for all energy. Much of an object’s energy is stored internally to the object in atoms, chemical and thermal energy. If an object is in motion, that motion is called kinetic energy. If an object is a ball sitting on top a hill, it has potential energy which can be converted to kinetic energy by pushing the ball down the hill. Potential energy can also come from forces in various kinds of fields. Some of these different energies are affected by speed such as kinetic energy or momentum.

The relation between mass, energy, and light was monumental. This supercharged the world of quantum mechanics. The special theory of relativity tells us about how mass is converted to energy as the mass is accelerated towards the speed of light. There is a common misunderstanding that mass increases to infinity as something is accelerated or near the speed of light. Remember that rest mass is always the same in any inertial frame as I already stated. What changes is something in the inertial mass which is called relativistic mass.

Relativistic mass is mass which is dependent on the observer and their frame of reference relative to another frame of reference. However, relativistic energy is usually used instead of relativistic mass. Remember relativistic mass and energy are proportional to

the speed of light squared. When an object is moving slowly its relativistic mass is almost equal to its rest mass although the measured units are different. Rest mass is the smallest amount of mass an object can have. Relativistic energy will change with the speed of light as an object's kinetic energy gets closer to the speed of light. We can also see from the mass-energy equivalence formula that the relativistic mass will change. Massless particles like photons have no rest mass but a lot of kinetic energy as they travel at the speed of light. This means they have relativistic energy squared from their momentum squared times the speed of light squared from Formula 2, $e^2 = p^2c^2$ or simply $e = pc$.[13] This is convenient as massless particles like photons can be used with relativistic mass or momentum.

A Deeper Dive - Inertial Mass

Mass is often taught as bending spacetime but technically mass is defined as a measure of a body's inertia. Inertia is the body's resistance to acceleration when a force is applied to the body. Newton's first law of motion states that a body at rest remains at rest, and a body in motion remains in motion at constant speed and in a straight line unless acted on by an unbalanced force. The resistance to a body's change in motion is inertia.

> There are a few distinguishing characteristics of an inertial frame of reference.
>
> Inertial reference frames are homogeneous and isotropic. The same properties apply in all locations and all directions within the frame.
>
> There is no acceleration of the frame.
>
> The law of inertia holds true within the frame.
>
> The laws of physics are the same in all inertial reference frames. [14]

Homogenous means the same throughout. On a large scale, the universe is assumed to be made of the same stuff in all directions. However, we know on smaller scales it is heterogenous or made up of many different things. For example, we can look at an atom as a point-like particle to see how it functions in molecules. However, if we look deeper into an atom, we know it is composed of many smaller particles. Isotropic means regardless of what direction we look at something, it looks the same. When we look at the stars in the universe at night, no matter what direction we look, we see stars. This is an example of isotropic.

Here is an example of an inertial frame,

> One example of an inertial frame of reference is a train platform. The platform is motionless, so it meets the criteria of no acceleration. Objects on the platform follow the law of inertia. A ball rolling across the platform will continue rolling at a constant velocity until an outside force acts on it. A bench on the platform will not move without the action of some external force. This would hold true for the entire area of the platform. A train approaching the platform also follows the laws of inertia. It slows down only when the force of the brakes is applied. Without this force, it would continue past the platform at a constant speed. An inertial frame of reference may exhibit motion, as long as that motion is at a constant speed and maintains its direction of travel. One example of this is a car set on cruise control to maintain a steady pace that is traveling on a straight road.[15]

Throughout this book I will refer to mass as bending spacetime but the resistance to a force applied to a body undergoing acceleration, as in the curvature of spacetime, is a more technically accurate way to think about the effect of mass on spacetime.

On a related point, many of us have heard that mass increases to infinity at the speed of light. In this case, if by ‘mass’ we mean the

size of something would have to go to infinity at the speed of light that would be wrong. Mass as size does not actually increase. What really goes to infinity is inertia as kinetic energy increases. Remember inertia is a property that defines mass. To accelerate inertial rest mass towards the speed of light requires more and more energy to overcome an object's resistance to change in its motion. This energy is largely due to the part of the kinetic energy or relativistic mass as the accelerated mass approaches the speed of light. Remember, according to Einstein's equation $e = m_{rel}c^2$ energy and relativistic mass are convertible. Therefore, we can say mass is increasing as we accelerate an object towards the speed of light but technically, we are really adding more and more energy resulting in more resistance to a change in motion or inertial mass. Here is what is more technically meant by 'mass increases to infinity at the speed of light',

> So how can this "mass increase" be understood? As usual, Einstein had it right: he remarked that every form of energy possesses inertia. The kinetic energy itself has inertia. Now "inertia" is a defining property of mass. The other fundamental property of mass is that it attracts gravitationally. Does this kinetic energy do that? To see the answer, consider a sphere filled with gas. It will generate a spherically symmetric gravitational field outside itself, of strength proportional to the total mass. If we now heat up the gas, the gas particles will have this increased (relativistic) mass, corresponding to their increased kinetic energy, and the external gravitational field will have increased proportionally. (No-one doubts this either.)
>
> So the "relativistic mass" indeed has the two basic properties of mass: inertia and gravitational attraction. (As will become clear in the following lectures, this relativistic mass is nothing but the total energy, with the rest mass itself now seen as energy.) [16]

Mass and Higgs

Particles that travel at and near the speed of light do not gain mass like something we visualize getting bigger and bigger but more properly, inertial momentum which defines mass, goes to infinity at the speed of light. In this way rest mass is converted to relativistic mass or energy. There is actually a field created by the Higgs boson in the Standard Model (to be discussed later). The Higgs field gives mass to most of the particles in the Standard Model (with spin zero) but not to the Higgs particle itself. The Higgs field is not universal as homogeneously everywhere in space or in the sense of giving mass to such things as neutrons and protons. Even dark matter and blackholes do not get their mass entirely from the Higgs field. [17] The Higgs boson was the last particle to be discovered in the Standard Model which was predicted all the way back in 1964. In 2012 it was found by the Large Hadron Collider. Actually, the Higgs field, which is really the tiniest or dimmest wave-like ripple, is what gives mass to certain elementary particles.

> The Higgs field (unlike most of the elementary fields of nature) has a non-zero average value throughout the entire universe. And because it does, many particles have mass, including the electron, quarks, and the W and Z particles of the weak interactions. If the Higgs field's average value were zero, those particles would be massless or very light. That would be a disaster; atoms and atomic nuclei would disintegrate. Nothing like human beings, or the earth we live on, could exist without the Higgs field having a non-zero average value. [18]

For now, what I discussed concerning inertial mass and spacetime curvature which Newton's gravity declared as action-at-a-distance finds something 'strange' in quantum physics - the Higgs boson.

First Look at Higgs Boson

This Higgs boson is a particle which is associated with the Higgs field. This field converts energy into mass. Without the Higgs field nothing could move slower than the speed of light because there would be no mass in the universe. Here are some facts about the Higgs boson:

> The Higgs boson is the fundamental particle associated with the Higgs field, a field that gives mass to other fundamental particles such as electrons and quarks. A particle's mass determines how much it resists changing its speed or position when it encounters a force. Not all fundamental particles have mass. The photon, which is the particle of light and carries the electromagnetic force, has no mass at all…
>
> The Higgs boson gets its mass just like other particles—from its own interactions with the Higgs field.
>
> There may be more than one Higgs boson. One theoretical model of new physics predicts five Higgs bosons.
>
> Fundamental particles in our universe acquire mass through their interactions with the Higgs field.
>
> The Higgs boson can be a unique portal to finding signs of dark matter due to its own distinctive characteristics and properties. [19]

The lifespan of the Higgs boson is very short which is why it took so long to find.

> The Higgs boson is peculiar in many respects. Like most other elementary particles, it is unstable and lives only for an extremely short time, 1.6×10^{-22} seconds, according to the established theory of particle physics (the standard model). [20]

The Higgs field is thought to be present in many places in the universe.

> For the Higgs particle to give mass to others it would need to permeate the universe. All of space would be filled with a sea of virtual Higgs bosons – now known as the Higgs field – that pop in and out of existence. In the theory, while massless photons and gluons ignore the Higgs field, quarks, electrons and other particles interact with it, which is why these particles have mass. [21]

Massless particles like the photon, the smallest unit of light, travel at the speed of light. Other subatomic particles can acquire or lose mass as they acquire or lose energy. Einstein's famous formula for how energy and mass is converted is $e = mc^2$. Without the Higgs field this formula would not be valid, and neither would we.

> Albert Einstein's 1905 theory of special relativity is one of the most important papers ever published in the field of physics. Special relativity is an explanation of how speed affects mass, time and space. The theory includes a way for the speed of light to define the relationship between energy and matter — small amounts of mass (m) can be interchangeable with enormous amounts of energy (E), as defined by the classic equation E = mcˆ2.
>
> Special relativity applies to "special" cases — it's mostly used when discussing huge energies, ultra-fast speeds and astronomical distances, all without the complications of gravity. Einstein officially added gravity to his theories in 1915, with the publication of his paper on general relativity.
>
> As an object approaches the speed of light, the object's mass becomes infinite and so does the energy required to move it. That means it is impossible for any matter to go faster than light travels. This cosmic speed limit inspires new

realms of physics and science fiction, as people consider travel across vast distances. [22]

With this in mind, recall that Einstein and company left us in dialectical opposition with the very large, spacetime, and the very small, quantum physics. As we will see, we can now gravitate towards reconciling these oppositions in terms of gravity and the other three forces: the electromagnetic force and the weak and strong nuclear forces. This path brings us to major new areas in physics such as quantum gravity, quantum weirdness, quantum entanglement, and the end of our conception of the universe as we have become accustomed to knowing it…buckle up!

Einstein's Special and General Relativity

General relativity breaks spacetime up into chunks or segments called a frame. If a randomly chosen frame is not being accelerated, it is called an inertial frame of reference or simply a frame of reference. Even though there are no frames in the universe that are at rest, inertial frames of reference are useful sometimes from a visualization point of view. However, inertial frames of reference are older than general relativity frames. General relativity frames are more accurately frames that are accelerating relative to each other. However, I think inertial frames of reference are easier to understand for most of us since the reference frame is a purely abstract idea which considers some random frame to be at rest to another accelerating frame. In the Einsteinium universe there is no 'reference frame' as all frames are accelerating relative to each other. Let's explore inertial frames further.

First, let's remember that inertia is resistance to a body's change in motion. Let's explore another narrative of Einstein's elevator thought experiment concerning gravity as simply acceleration. If I am inside a spaceship accelerating quickly in free space where spacetime curvature is small, I will still find it very difficult to get

up and move around because the inertial frame I am in is accelerating making it difficult for me to move around freely. This is due to the spaceship's inertial frame's resistance to a change in motion even though outside the spaceship there is free space with negligible effects from a gravitational field. If I am not accelerating in the spaceship, the inertial frame may be thought to not be moving at all either with no velocity or moving at a constant velocity. There is no acceleration if your car is going at exactly 60 mph on the interstate. Additionally, if our car is going exactly 60 mph and another car ten miles ahead of us is also going exactly 10 mph, we are both in the same inertial frame because we are not accelerating away from each other. We are simply traveling at different speeds or velocities. Classic physics and Einstein's special theory of relativity in 1905, by definition, are unaccelerated as they have no spacetime frames accelerating or decelerating relative to each other, all cars on the road might be traveling at different speeds but not accelerating or decelerating relative to each other from their spacetime frame. General relativity considers frames accelerating relative to each other. At lower speed compared to the speed of light inertial mass is small, kinetic energy is insignificant compared to kinetic energy closer to the speed of light, and rest mass factors in more heavily. However, close to the speed of light Newton's universe fails and relative inertial frames impacts spacetime extremely. This is also where relativistic quantum mechanics becomes important. General relativity mathematics uses something called tensors to account for accelerating relative frames of reference. When speeds are lower compared to the speed of light non-relativistic quantum mechanics works well with Einstein's special theory of relativity. Relativistic quantum mechanics and non-relativistic quantum mechanics will be discussed in more detail later.

Classical mechanics notably espoused by Newton had three laws of motion:

> An object at rest remains at rest, and an object in motion remains in motion at constant speed and in a straight line unless acted on by an unbalanced force.
>
> The acceleration of an object depends on the mass of the object and the amount of force applied.
>
> Whenever one object exerts a force on another object, the second object exerts an equal and opposite on the first. [23]

Newton also treated gravity as just another force designated as 'G'. Newton knew nothing of spacetime curvature. But Newton did work out a very good theory of how the force of gravity works. Newton found that *every particle attracts every other particle in the universe with a force that is proportional to the product of their masses and inversely proportional to the square of the distance between their centers*. [24] This worked well with lower speeds not approaching the speed of light. Non-relativistic is a term used to describe physics *at speeds* much smaller than the speed of light. [25] And since we know that energy and light are related by Einstein's most famous formula, we can also say that non-relativistic physics has lower energy than relativistic physics. At higher speeds approaching the speed of light 'c', Einstein's special relativity addresses the physics of motion and its effects on mass. Relativistic is a term which is used to describe physics which is closer to or equal to the speed of light. As you might suspect, relativistic physics is much more complicated than non-relativistic physics.

As one of the most successful theories in the history of physics, both Einstein's special theory of relativity and his general theory of relativity are probably at the top. There is a lot of pressure on theoretical physicists to incorporate relativity into quantum mechanics (or vice versa) because of how successful relativity has been. When we think about non-relativistic quantum mechanics, we are looking at cases where a particle's kinetic energy is small relative to its total mass energy. Another way of thinking this is in non-relativistic quantum mechanics a particle's resistance to

acceleration or inertial mass specifically close to or near the speed of light can be minimized, neglected, or worked around with a bit of fudging. When we think about relativistic quantum mechanics, we are looking at cases where a particle's inertial mass, its resistance to acceleration specifically close to or near the speed of light, cannot be minimized or neglected.

Think about length contraction for a ruler. In our frame of reference, a ruler is twelve inches long. This is non-relativistic. However, if we were to look at a ruler in an accelerated frame of reference closer to the speed of light the ruler would be shorter than twelve inches due to length contraction. [26] Actually, this could not be done practically because the amount of kinetic energy to get an intact ruler close to the speed of light would move towards infinity. However, if a ruler could be accelerating intact close to the speed of light, the ruler would get closer and closer to zero length while observing it from our relative reference frame because of its inertial relativistic mass. As we will see with general relativity, the speed of light affects physics in ways which fundamentally change the way we think of 'realities' such as time and size. We will also see later that quantum physics seems to be caught in a duality between wave-like and particle-like characteristics called wavicles which is pervasive, unresolvedly contradictory, and dependent on how we set up our experiment, how we observe it, which is not some kind of illusion but actually in 'reality' how the observation itself changes the phenomenon itself. There are also dualities we will see on very large scales such as blackholes which depend on how we are looking at a blackhole, from the outside or the inside, echoes in the odd dualities of wavicles. So, we may find that the final 'theory of everything' will also have to live with these spooky dualities while exceeding them.

Galilean relativity is the principle that all laws of motion are the same in all inertial frames of reference. An inertial frame of reference is a space that is not undergoing any acceleration. It is a space where Newton's first law of motion holds which states "*Every*

body continues in its state of rest, or of uniform motion in a straight line, unless it is compelled to change that state by forces impressed upon it." [27] Non-relativistic quantum mechanics is a mathematical formulation of quantum mechanics based on Galilean relativity.

Non-relativistic quantum mechanics refers to the mathematical formulation of quantum mechanics applied in the context of Galilean relativity, more specifically quantizing the equations of classical mechanics by replacing dynamical variables by operators. Post-Einstein relativity and quantum physics has found places for non-relativistic quantum mechanics and relativistic quantum mechanics.

In 1632, Galileo discovered that the resistance of an object to change its motion was the same everywhere or more specifically, that the laws of motion are the same in all inertial frames of reference. For example, an observer below the deck of a ship would not be able to tell whether the ship was moving or stationary if the ship was traveling at constant velocity, without rocking, on a smooth sea. Non-relativistic quantum mechanics allows us to replace certain variables in formulas of classic (Galilean) mechanics with operators or functions in quantum mechanics. With assumptions that the speed of light or inertial mass and thus has lower energy is not relevant and our frame of reference is not undergoing any acceleration, classic mechanics can quite beautifully live on as a limited case of Einstein's relativity. Within that framework, non-relativistic quantum mathematics allows quantum physics to explain phenomena apart from what we know as the relativity of spacetime where gravity or inertial mass and the speed of light become an issue. Non-relativistic physics is useful in situations where the speed of light and high energy are not crucial factors because it is 'relatively' easier to use and does not require the accuracy of relativistic physics. Nuclear physics which deals with the strong forces of the nucleus and weak forces of electrons is generally not high enough energy for relativistic quantum physics.[28] However, relativistic quantum physics is more useful for high

energy physics, particle physics, and accelerator physics.[29] This is because it can tell us more about massive particles accelerating close to the speed of light and even massless particles.

Relativistic quantum mechanics is used with Einstein's special theory of relativity. Its most successful implementation is in Quantum Field Theory (QFT). In quantum field theory elementary particles like those in quantum physics' Standard Model are used as field quanta. That is, discrete and very small particles are used in a field (e.g., like a magnetic field with flux lines) more like how ocean currents affect waves. Quantum field theory is uniquely qualified to explain how virtual particles can pop in and out of existence. This is also called zero-point energy. Heisenberg's uncertainty principle requires that zero-point energy exists.

> The trouble arises from the bizarre nature of the quantum vacuum, which is a peculiar type of nothing that comes dangerously close to resembling a something. The uncertainty principle forbids any quantum system from settling down into a perfectly quiet state of exactly zero energy. As a result, even the vacuum must always crackle with fluctuations in the quantum fields that fill it. These never-ending fluctuations imbue every field with some minimum amount of energy, known as the zero-point energy. [30]

Effectively, zero-point energy means we do not need to have a certain number of particles which are conserved in quantum transactions, morphing from one state into another. This is because fields are wave-like not particle-like. [31] More on that later. Before I get into inertial frames with no acceleration, we need to discuss gravity. So, what is gravity?

Newton described the force of gravity as an action-at-a-distance. It was some invisible force that existed in space which acted from distances to move objects. Classical physics thought of a force as

pushing or pulling an object. If I push a swing on the earth or in space, it will always act locally to move the swing no matter how I am oriented in space. Why is gravity different?

If a high-altitude airplane takes a deep dive while I am unrestrained sitting in a chamber, I will begin to float at some point. Did gravity simply go poof because I am weightless? When I am in an elevator going down, I feel lighter briefly until I get to the bottom where the elevator decelerates to a stop where I feel heavier than normal. Did gravity change? What changed was acceleration and deceleration.

All forces except gravity act locally no matter where they are. If gravity were like a force acting locally no matter how I was oriented in space, I could never reach an acceleration where I would float. So, calling gravity a force contributes to a bit of confusion about how forces act locally regardless of where it is in space. Gravity is simply acceleration. The geometric warping of spacetime is the source of acceleration. Since gravity emerges from spacetime geometry it is not like forces which act locally.

> Gravity is indeed a real force, but not in the traditional sense. In other words, gravity is not a direct, classical, action-at-a-distance force between two objects. However, in the broader sense, gravity is indeed a force because it describes the resulting interaction between two masses. Gravitational effects are fundamentally caused by the warping of spacetime and the motion of objects through the warped spacetime. However, the end result is as if a force was applied. Therefore, the most accurate approach would be to call gravity an "emergent force," meaning that what looks like a direct force is actually emerging from more fundamental effects (the warping of spacetime). With this in mind, it is perfectly reasonable to call gravity a real force. [32]

Think of how satellites orbit the earth. They keep moving

around the earth in a circle. This is because when no force is acting on them. The easiest path for them is to simply follow the spacetime curve they are moving on. If they go higher or lower in their orbit some thrust would have to be applied to make them leave the spacetime curve they are following. We all want to follow the path of least resistance and for a satellite this means the curvature of space.

Here is a way to think about spacetime geometry and how it acts. Think of a boat on the ocean. If the boat is following the course of the prevailing current, it could merely float along with the current. However, if the boat wanted to leave the current and go in another direction, it would have to apply thrust, a local force, to resist the flow of the current. The amount of thrust would depend on the direction it goes against the current. As the boat moves at an angle from the direction of the ocean's current until it is moving directly against the direction of the ocean's current, it would have to apply more and more force. When going fully against the ocean's current, it would have to apply a maximum amount of force to counteract the ocean's current. Spacetime acts just like the ocean's current. Satellites simply follow the current of spacetime. If they want to go higher or lower in orbit, they will need to apply thrust. If they want to go straight up against the flow of spacetime, they need a maximum amount of thrust. Now think of a boat in a massive whirlpool. As the whirlpool gets deeper and deeper, it will take more and more thrust to accelerate out of the whirlpool. The earth sits in a geometric spacetime well bent by the mass of the earth.

Spacetime is bent by the effect of inertial mass on spacetime, not some kind of local force called gravity. Additionally, the maximum amount of bent spacetime is located at the inertial center of the mass. The inertial center of mass is made up of the types of material, the densities, and the geometric shape of an object. Since the inertial center of mass of the earth is somewhere near the center of the earth, people on the 'bottom' of the earth do not fly off. This

is also why everywhere on the earth has approximately the same amount of weight. Weight is simply acceleration like when you accelerate or decelerate in a car or an elevator. So, what we are feeling as weight is really the curvature of spacetime, the spacetime current moving us toward the center of the earth. So, what is an inertial frame in Einstein's relativity?

The **inertial center** of a mass can have **translational movement** (moving linearly) and can also serve as the point for a **rotational axis** (the imaginary line an object revolves around). If a sphere were made up of all the same material with all the same densities of the material in the sphere, the center of mass would be the center of the sphere. A sphere of this type which is composed of all the exact same matter as that would be hard to find in the universe. In most cases the word 'center' will likely not be the center of an irregularly shaped object with different material and densities. Additionally, if we want to compare two dynamic systems, it is much more complicated to try to describe two dynamic systems in motion simultaneously than it is to describe one dynamic system from the point of view of a static, non-accelerated, system looking towards a dynamic, accelerated system. For example, if we want to mathematically understand the motion of the moon around the earth, we could describe the earth and the moon moving simultaneously around the sun. In that case, we will have a higher level of mathematical abstraction to deal with. On the other hand, if we just care about the motion of the moon around the earth, why not choose a point of reference on the earth? In this case, it does not matter how the moon is moving translationally around the sun. So, even though both the moon and the earth have the curvature of spacetime acceleration, called gravity, and rotational momentum counteracting the sun's gravitational attraction working on them, it is easier to consider the earth as not accelerating, as an inertial frame of reference, to understand the motion of the moon around the earth.

> In order to describe an object's motion, there must be a frame of reference with which it can be compared. In the physical world, the frame of reference includes the external surroundings of the object of interest. For example, if a bowling ball is rolling down the alley, the reference frame includes the surface of the alley floor itself. Within the study of physics, a reference frame is simply a set of coordinates, which are used to determine properties like position and velocity. Such a frame typically includes axes that define the three dimensions of space within the frame of reference. [33]

Any point or region in the universe can be an inertial frame of reference for whatever other point or region in the universe, called a relative frame, we are interested in studying. We just abstractly define our frame's acceleration as zero and compare that to the motions in the accelerating frame. By the way, in a quite different sense of spatiality, we do this in common sense all the time. When we are walking down a hallway, we are not considering our motion relative to the motion of the hallway's distances to its vertical and horizontal walls changing through time consciously. This would be the definition of dizzy. We are circumspectly orienting ourselves to the hallway in what phenomenology thinks of as regionality, lived spatiality, not abstract linear extension where processes are calculated in terms of the mathematics of Cartesian coordinates. More on that later.

Time Dilation and Length Contraction

As I previously discussed, we can assume that our frame is not accelerating or decelerating. This is an inertial frame of reference. Our frame could not be moving at all or moving at a constant speed or velocity. It doesn't matter. Think of sitting in your car on the side of the road or on the interstate going sixty mph. If another car is sitting still by your stationary car or driving at 60 mph next to your

60-mph car, both cars' clocks are running at the same speed. In the classical world, all clocks will always run at the exact same time. We can call this absolute time. And so, we thought for millennia that time was absolute. However, reality changed with relativity and the inertia of common sense has yet to catch up with it.

As stated, we have pronounced our car as the 'inertial frame of reference'. At speeds approaching the speed of light, any other frame's clock accelerating away from our inertial frame will have a clock which increasingly looks to us like it is running slower as it gets closer to the speed of light. However, in each frame both clocks are running perfectly normal. As the other frame is accelerating relative to the speed of light, we see the other frame's clock slowing down. Time has not changed in each classical frame but looking from our inertial frame to the other frame, even though both clocks are running normally in their perspective frames, the other relative frame's clock is running at a slower rate relative to our frame of reference. This phenomenon is called 'time dilation'. Since space is time and time is space, size behaves the same way. If I look at a 12-inch ruler accelerating closer to the speed of light in another relative frame, it will increasingly look shorter than my ruler even though both rulers are still twelve inches in their own frame. This is called 'length contraction'. Another way to think about this is, if one of the frames is accelerating relative to the inertial frame of reference the light waves arriving at the inertial frame will be compressed or expanded. While thinking in terms of light waves arriving at the inertial frame is more intuitive, it is merely an easy way to *think* of time dilation. Time dilation actually affects aging.

> It really is all relative: Former NASA astronaut Scott Kelly's historic one-year mission aboard the International Space Station (ISS) made his identical twin Mark an even older brother.
>
> The unprecedented jaunt, which ended this past March, brought Scott Kelly's total time in orbit to 520 days — all of

which he spent zooming around Earth at 17,500 mph (28,160 km/h).

Albert Einstein's theory of special relativity holds that time moves more slowly for objects in motion compared to a stationary observer, and experiments have borne out this prediction. This "time dilation" is most dramatic and noticeable at relativistic speeds, but the effects manifest even at the much lower velocities experienced by bodies in Earth orbit.

"So, where[as] I used to be just 6 minutes older, now I am 6 minutes and 5 milliseconds older," Mark Kelly said Tuesday (July 12) during a panel discussion at the ISS Research & Development 2016 conference in San Diego. Scott Kelly also participated in the panel, which was moderated by CNN TV personality Sanjay Gupta and webcast live. "Now I've got that over his head."

Mark Kelly is also a former NASA astronaut; he logged a total of 54 days in orbit over the course of four space shuttle missions between 2001 and 2011. But Scott Kelly's greater exposure to space radiation could end up aging him prematurely, Mark joked.

"So if 10 years from now, I look like I'm 60 and he looks like he's 80, you'll know what happened," Mark said. (The brothers are 52.)

"Mark got Botoxed, is what happened," Scott shot back, drawing a laugh from the audience.[34]

So, time dilation has 'real' effects on biology. Additionally, inertial mass affects clocks as well. If you live at the top of a mountain further from the inertial center of mass of the earth, you will be a tiny amount younger when you come down to sea level. These effects are not just related to light arriving at our frame of reference. They are ‘real’ in the way we commonly think of ‘real’. This puts the notion of 'real' in a totally different light!

The Speed of Light

Thinking about light, what would happen if you could travel at the speed of light? Light is composed of photons. They are massless so they can travel at the speed of light. For anything with mass, the speed of light is a limit. We know from calculus what a limit is. In calculus, you can never reach some limits, but you can keep adding decimal places forever. This is called asymptotic.

> By the way, 99.99% of the speed of light is not the record for particle accelerators. Scientists can accelerate subatomic particles to much higher speeds. The record was achieved in a particle accelerator located in Europe at which electrons were accelerated to the jaw-dropping velocity of 99.9999999987% the speed of light. In that incredible environment, Einstein's equations still worked perfectly. At these speeds, a hypothetical clock accompanying the electrons would tick a little over 200,000 times slower than a clock near a stationary electron. [35]

99.9999999987% is getting there but still a long way from infinity. As objects with mass approach the speed of light their inertial mass increases towards infinity. This means to get anywhere near that limit, we need to start with a subatomic particle which has very low inertial mass. This 'jaw-dropping' world record in velocity was achieved in a particle accelerator. We know that from our perspective, our inertial frame, we will see time slow down and size shrink as an object gets closer and closer to the speed of light.

Let's assume that the phenomenon we call the universe is different from calculus. Interesting enough, time would also stop if the limit of absolute zero Kelvin could ever be achieved. We can get very close to absolute zero Kelvin, but we would never get there just as we could never get to the speed of light. At the speed of light, both time and absolute zero Kelvin, everything stops.

However, realistically for absolute zero Kelvin there would still be quantum jitter and very small energy fluctuations which never stop. So, how do we see light travel through the universe?

Light in a perfect vacuum would travel at a fixed speed of approximately 186,282 miles per second. Everything else we perceive is purely relative to that. Also, light is both wave and particle so how we see it is relative to our perspective. Light is a spectrum which far exceeds the visible spectrum. Light can appear to transform for example when electrons change their energy cloud orbits around an atom. They appear to either absorb or emit a photon when they increase or decrease their quantum energy level. However, these changes are not due to something like the photon itself changing. It is more a matter of magnitudes of observation. From our perspective we perceive that light can slow down slightly in different kinds of mediums. But how would a photon 'see' the universe while traveling at the speed of light?

If a photon could see, time would stop, and the universe would shrink to size zero. From within a photon's frame of reference, the universe does not exist since time does not exist and, since space is time and time is space, the universe does not exist. Another way to say this is that we achieve a limit where time *is* zero and all points in the universe exist simultaneously everywhere along the photon's path of travel.

> Relativity is certainly a nonintuitive theory, and it makes some very bizarre predictions. However, perhaps the most bizarre of all is that light experiences neither time nor space, existing in all places and all times at once. This crazy-sounding result reminds us that the laws that govern the Universe are weird and wonderful — and it gives us much to ponder.[36]

The photon has the capacity to transform itself popping in and out of existence as do all elementary particles. As we will see later,

photons can cease to exist in vacuum energy, as opposed to slowing down and popping into existence again, as they travel through space. Here is yet another case where what we think we see is not at all congruent with what '*is*'. This should cause us to reflect on what we take for granted as 'real' as opposed to forever trying to adapt our notion of 'reality' to our ideas.

The Battle of the Titans

Relativity has a brutal clash with quantum mechanics. Craig Hogan is a theoretical astrophysicist at the University of Chicago and the director of the Center for Particle Astrophysics at Fermilab. I think this article lays it out quite nicely,

> A basic assumption in Einstein's physics – an assumption going all the way back to Aristotle, really – is that space is continuous and infinitely divisible, so that any distance could be chopped up into even smaller distances. But Hogan questions whether that is really true. Just as a pixel is the smallest unit of an image on your screen and a photon is the smallest unit of light, he argues, so there might be an unbreakable smallest unit of distance: a quantum of space.
>
> In Hogan's scenario, it would be meaningless to ask how gravity behaves at distances smaller than a single chunk of space. There would be no way for gravity to function at the smallest scales because no such scale would exist. Or put another way, general relativity would be forced to make peace with quantum physics, because the space in which physicists measure the effects of relativity would itself be divided into unbreakable quantum units. The theatre of reality in which gravity acts would take place on a quantum stage.
>
> Hogan acknowledges that his concept sounds a bit odd, even to a lot of his colleagues on the quantum side of things.

Since the late 1960s, a group of physicists and mathematicians have been developing a framework called string theory to help reconcile general relativity with quantum mechanics; over the years, it has evolved into the default mainstream theory, even as it has failed to deliver on much of its early promise. Like the chunky-space solution, string theory assumes a fundamental structure to space, but from there the two diverge. String theory posits that every object in the universe consists of vibrating strings of energy. Like chunky space, string theory averts gravitational catastrophe by introducing a finite, smallest scale to the universe, although the unit strings are drastically smaller even than the spatial structures Hogan is trying to find.

Chunky space does not neatly align with the ideas in string theory – or in any other proposed physics model, for that matter. "It's a new idea. It's not in the textbooks; it's not a prediction of any standard theory," Hogan says, sounding not the least bit concerned. "But there isn't any standard theory, right?"

If he is right about the chunkiness of space, that would knock out a lot of the current formulations of string theory and inspire a fresh approach to reformulating general relativity in quantum terms. It would suggest new ways to understand the inherent nature of space and time. And weirdest of all, perhaps, it would bolster the notion that our seemingly three-dimensional reality is composed of more basic, two-dimensional units. Hogan takes the "pixel" metaphor seriously: just as a TV picture can create the impression of depth from a bunch of flat pixels, he suggests, so space itself might emerge from a collection of elements that act as if they inhabit only two dimensions.[37]

But mathematics, its history and conventional establishments want to reconcile seeming irreconcilables. Enter quantum field

theory. Are fields the key to this reconciliation? Relativity has frames and quantum physics has fields. It seems intuitive that frames and fields might have some congruity with one another. But quantum fields, unlike frames "*come in many varieties and fluctuate like a rolling ocean. As the fields ripple and interact with each other, particles emerge out of them and then vanish back into them, like the fleeting crests of a wave.*" [38] As this article further states, "*Particles are not objects that are there forever," said Tong. "It's a dance of fields.*" [39] It seems that here we are bumping into contradictions, the vast differences and unities, of waves and particles. But quantum field theory is so vastly complicated that even mathematicians are perplexed by its rapid propensities towards infinites. When we think of the smoothness of Einstein's spacetime we see continuity and wavelike relative frames. We intuitively think that the closer we look at frames the more continuity we will find. Not so with quanta, the closer we look the more unmanageable infinites jut into our desired fluidities. The compromise to these contradictions is to limit perturbations, factors which can perturb our sense of mathematical rationality. The hope is that by limiting our scope we can expand our horizontal perspectives. If we can make sense of small things maybe larger things will simply be a repetition. As we will see this dream appears to evaporate in the spookiness of our observations – the quantum wave function. When we peer deeply into our assumptions of Latin's *ratio*, "*It is possible to trace the origin of the word "ratio" to the Ancient Greek* λόγος *(logos). Early translators rendered this into Latin as ratio ("reason"; as in the word "rational").*" [40] - we see chaos.

Why Planck?

In mathematics, we can talk about infinities or infinitesimals and make perfect sense. However, quantum physics is about quanta which can be very large or very small but not infinitely large or small. There are limits based on our current understanding of

physics which impose practical units to how big or small fill-in-the-blank can be. In quantum physics these units are Planck units, named after Max Planck (1858-1947), which is universal to this universe at least. These units pop up everywhere in quantum mechanics. We might ask, what is the significance of Planck units?

In 1887 Heinrich Hertz (1857-1894) proved the existence of electromagnetic waves predicted by James Maxwell's (1831-1879) equations of magnetism. Maxwell had proposed that light was composed of electromagnetic waves, but no one had proved the existence of these waves until Hertz rather unknowingly stumbled upon free space electromagnetic radio waves.

Hertz did not realize the practical importance of his radio wave experiments. He stated that,

It's of no use whatsoever ... this is just an experiment that proves Maestro Maxwell was right—we just have these mysterious electromagnetic waves that we cannot see with the naked eye. But they are there.

Asked about the applications of his discoveries, Hertz replied,

Nothing, I guess [41]

Planck discovered, somewhat begrudgingly at first, that he had stumbled upon the fact that the universe was not composed of infinities and infinitesimals, but discrete units. Planck was steeped in classic physics which initially made him believe that electromagnetic wave's energy ranged from infinitesimally small to infinitely large. However, Planck's own experiments showed him that in an ideal environment called black body radiation, energy, or heat was emitted in discrete steps which he deemed "a quantum of action". [42] Planck desperately tried to reconcile his findings to classical physics' smooth assumptions of infinites and infinitesimals.

Planck was deeply suspicious of the philosophical and physical implications of such an interpretation of Boltzmann's approach; thus his recourse to them was, as he later put it, "an act of despair ... I was ready to sacrifice any of my previous convictions about physics". [43]

The central assumption behind his new derivation, presented to the DPG on 14 December 1900, was the supposition, now known as the Planck postulate, that electromagnetic energy could be emitted only in quantized form, in other words, the energy could only be a multiple of an elementary unit:

$E = hv$

where h is Planck's constant, also known as Planck's action quantum (introduced already in 1899), and ν is the frequency of the radiation.

Planck postulated in 1900 that the total energy of the black body radiation was equal to the frequency of its radiation times an odd constant which we call Planck's constant. This discovery was a substantial step away from classical infinites and infinitesimals into a strange world of quanta. Planck won the Nobel Prize for Physics in 1918 for his fundamental contribution to 'a new branch of physics'. [44] I want to digress briefly here to make an important point.

Not much later in 1905 Einstein published papers on special relativity. Einstein proposed that electromagnetic waves of light were composed of quanta called photons. He also showed the relationship of this electromagnetic radiated energy to frequency is that energy is equal to Planck's constant times frequency.

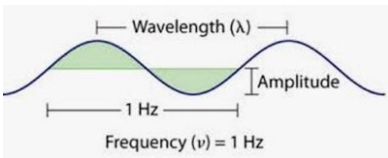
$E = hf$, where 'E' is energy, 'h' is Planck's constant, and 'f' is frequency of the radiated photons. [45]

This equation also works for other quanta besides photons including electrons, protons, quarks, and neutrinos. However, what is meant by 'frequency' is more nuanced with quanta other than photons. [46]

Meanwhile, Louis de Broglie (1892-1987) gave us another fundamental look into this new branch of physics. He showed that momentum was related to Planck's constant divided by the wavelength of the frequency.

$P = h/\lambda$, where 'p' is momentum, 'h' is Planck's constant, the Greek letter lambda Λ which is upper case or λ is lowercase. [47]

Frequency (f) is generally cycles per second. The length of one cycle is the wavelength (λ). The time period (T) it takes for one cycle is equal to one divided by the frequency (T = 1/ f). From algebra this means frequency (f) is equal to one divided by the time period (T) or f = 1/T.



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So, if we substitute 1/T for frequency (f) in Einstein's famous equation E = hf we get E = h/T.

Now we have Einstein and de Broglie telling us,

$$E = h/T \text{ and } p = h/\lambda$$

These formulas apply on the smallest scales as well. This means they apply to the quantum level as well. I want to note here that frequency for some quantum particles gets a little more complicated but nevertheless, this tells us something quite remarkable about the quantum world:

energy (E) is to time (T) as momentum (p) is to wavelength or space (λ). 49

This association between momentum and energy and space and time respectively is something we will see over and over again in this book. The point here is that information about momentum of a particle can also be related to information about energy. And, as we will see, energy and entropy also have a relationship. Let's go back to the far-reaching implications of quanta as opposed to universals

and infinites of classicism.

Einstein's formula harkens back to Max Planck's blackbody radiation experiments. Frequency is the measure of the rate of quanta jitter and vibration. As energy is applied to quanta, the intensity or energy of quantum jitter and vibration increases not in a smooth fashion but in a chunky, discrete fashion. As energy decreases in quanta, the intensity or energy of quantum jitter and vibration decreases in a chunky, discrete fashion. The factor at which these discrete steps in energy occurs is:

$$6.62607015 \times 10^{-34}\ \text{J·Hz}^{-1}.$$ [50]

J·Hz^{-1} means it is the energy of electromagnetic radiation per unit of frequency. 10^{-34} is very small which makes the Planck constant only relevant on microscopic levels not our macro experiences of the daily world. The reduced Planck constant is symbolized as h bar or $\hbar$ which is simply equal to h/(2π) or $1.054571817 \times 10^{-34}$ J·s. This unit is used frequently as it has units of angular momentum. The reduced Planck constant, denoted as $\hbar$ (h-bar), is a fundamental physical constant in quantum mechanics. It relates to the Planck constant 'h' in the same way that hertz relates to radians per second. Specifically, one hertz corresponds to one complete cycle, which is equivalent to 2π radians per second. Expressing the Planck constant in radians rather than hertz simplifies certain calculations in quantum mechanics. It allows us to work with angular quantities more naturally, especially when dealing with wave functions, angular momentum, and other rotational aspects of quantum systems.

Planck's discovery demonstrated to us that there was a stepwise relationship between energy and frequency. Planck's constant also tells us that frequency goes up; energy goes up as seen in the previous formula, E = hf. **This meant, at bottom, the universe was not composed of infinities and infinitesimals but had minimums and maximums between which discontinuities were**

not smooth analog-like transitions from one energy level to the next. It turned out that these discontinuities conformed to the constants Planck had discovered and won a Nobel Prize in Physics in 1918. There are many other Planck units devised by Planck and later physicists which provide additional boundary conditions for physical conditions such as length, mass, time, charge, temperature, area, volume, momentum, torque, force, density, acceleration, etc. Torque is the measure of force that causes a particle to rotate around an axis or pivot point. Some of these constants are less certain than others but all of them reflect a universe to us that has some forms of limits and boundary conditions. Another interesting point is that when we get down to actual Planck units' predictions of the Standard Model of Elementary Particles, quantum field theory, and general relativity are not believed to apply. This is the level at which quantum gravity is expected to dominate. [51]

One way to think about Planck units is, if there is such a thing as the largest or smallest fill-in-the-blank what would that be? Can you keep multiplying or subdividing everything until you get to a point where any length, time, mass, force, energy, electric charge, magnetism, etc. cannot be multiplied or divided anymore and still maintain any semblance to something we call existence? What do I mean by 'semblance of existence'? Instead of thinking about the absolute largest or smallest 'thing', let's think about it this way. There is a limit to the largest or smallest fill-in-the-blank we can measure imposed not by us but by the physicality of the universe. These boundary conditions have limits with degrees of clarities and certainties. Below these limits the universe makes no sense but dissipates into chaotic uncertainty. We cannot 'know' the universe in the way much of early classicism, physics, philosophy, and religion, would have it. Classic philosophy has a persistent, universalizing insistence on epistemology, how we can 'know', and ontology, what we can know in existence. This history has filtered down to our inherited notions of commonsense. Extreme uncertainties in the areas have also been given historic forms which

relegate contraries to epistemology and ontology to categories like skepticism and cynicism. These absolutizing dualities admit no excess to their historic and more importantly, commonsense reductions.

There is one more important distinction about the Planck scale. When we get down to Planck lengths of 1.616255×10^{-35} meters, gravity is thought to be unified with the other three forces of electromagnetism, the strong nuclear force, and the weak nuclear force. Cosmology also believes at the earliest moment of the Big Bang, 10^{-43} seconds after the singularity, all of the four forces were unified as well.

> At the Planck length scale, the strength of gravity is expected to become comparable with the other forces, and it has been theorized that all the fundamental forces are unified at that scale, but the exact mechanism of this unification remains unknown. The Planck scale is therefore the point at which the effects of quantum gravity can no longer be ignored in other fundamental interactions, where current calculations and approaches begin to break down, and a means to take account of its impact is necessary. On these grounds, it has been speculated that it may be an approximate lower limit at which a black hole could be formed by collapse.
>
> While physicists have a fairly good understanding of the other fundamental interactions of forces on the quantum level, gravity is problematic, and cannot be integrated with quantum mechanics at very high energies using the usual framework of quantum field theory. At lesser energy levels it is usually ignored, while for energies approaching or exceeding the Planck scale, a new theory of quantum gravity is necessary. Approaches to this problem include string theory and M-theory, loop quantum gravity, non-commutative geometry, and causal set theory. [52]

We already have accepted a constant number for the speed of light which is equal to 299,792,458 meters per second; 186,000 miles per second; 671 million miles per hour. [53] As we will discuss later, cosmology tells us that the earliest moment of the Big Bang in which time made sense to current physics was in the Planck era at around 10^{-43} seconds after the singularity. The Planck era beginning is closely aligned with the Planck time constant, the smallest value at 5.391247×10^{-44} seconds. In this era, it is thought that quantum gravity would find its way into general relativity. [54] There is no time equal to zero in cosmology at the time of the Big Bang singularity. There is only a scale factor somewhere around 10^{-43} seconds before which any time scale would simply vanish. [55] Quanta are discrete but not infinite or infinitesimal. Planck units give us the limits imposed by the discrete chunkiness of the universe not the smooth classical absolute of infinites and infinitesimals. The primary Planck's units that have been derived subsequently by theories and proofs do not give us clear boundary conditions of the universe at the smallest scales and largest scales. As the primary Planck's units approach their limits the universe gets uncertain, murky, and even spooky. This is not because there is a prevailing hope that knowledge, epistemology, will swoop in one day to save the classical world. It is because fundamentally there is no fundamental, no essence, no absolute only chaos in which uncertainty undoes binaries like subject and object in a spooky fashion. Spacetime is not absolute but emergent from entangled information which has no allegiance to or recognition of dualities such as order/disorder, cause and effect, or Being and nothingness. The table below shows base Planck units along with derived Planck Units used and accepted in physics research.

Planck Units

Name	Dimension	Value (SI units)
Planck length	length (L)	$1.616255(18)\times10^{-35}$ m[7]
Planck mass	mass (M)	$2.176434(24)\times10^{-8}$ kg[8]
Planck time	time (T)	$5.391247(60)\times10^{-44}$ s[9]
Planck charge	electric charge (Q)	$1.875\,545\,956(41)\times10^{-18}$ C
Planck temperature	temperature (Θ)	$1.416784(16)\times10^{32}$ K[10]
Planck Area*	area (L^2)	2.6121×10^{-70} m2
Planck Volume*	volume (L^3)	4.2217×10^{-105} m3
Planck Momentum*	momentum (LMT^{-1})	6.5249 kg·m/s
Planck Torque*	energy (L^2MT^{-2})	1.9561×10^{9} J
Planck Force*	force (LMT^{-2})	1.2103×10^{44} N
Planck Density*	density ($L^{-3}M$)	5.1550×10^{96} kg/m3
Planck Acceleration*	acceleration (LT^{-2})	5.5608×10^{51} m/s2

This table offers a sample of derived Planck units, some of which are seldom used. Some of the derived units are mostly confined to specialized theoretical physics. Some of them are too large or too small for empirical or practical use. Additionally, on these scales there are uncertainties due to the inability to directly measure many of these values.

In my opinion, one of the most astounding discussions surrounding limits and boundary conditions has to do with the physicality of information limits. We tend to think that information is somehow detached from the physical world. We also tend to

think that information is unlimited. This is not so in quantum physics. Information has a limit dependent on volume. Perhaps the easiest way to think about this is in regard to quantum computing and qubits. In a later section of this book on "Quantum Computers" I will discuss qubits which are the smallest bundles of quantum information. Information for a particle could be something called spin, or position, or momentum. In quarks it might be up, down, charm, strange, top, and bottom. All these properties can be thought of as bits of information. But all of these properties take up a certain amount of density in a volume whether the volume is space, time, entanglement, etc.

The maximum theoretical data density in quantum physics is proportional to the area of the boundary of a given volume. For a uniform spherical volume of one cubic centimeter, the maximum amount of information that can be stored is approximately 10^{66} bits.

> We can now answer some of those elusive questions about the ultimate limits of information storage. A device measuring a centimeter across could in principle hold up to 10^{66} bits--a mind-boggling amount. [56]

This limit is derived from the Planck area, which is the smallest unit of area that has any physical meaning in the universe. The maximum information you can store is proportional to the area of the boundary of a given volume, and for a uniform spherical volume, that area is proportional to the square of its radius. Therefore, as the radius of a sphere increases, so does its surface area and hence its information storage capacity. [57] Quantum computing has sparked much research on information theory, complexity theory, and chaos theory adapted to quantum physics. [58]

Compatibility of Quantum Physics and Classical Physics

Bohr had a belief he called the correspondence rule. He thought that quantum physics was a natural replacement for classical physics. He thought that quantum physics was a natural generalization of classical physics. He simply saw classical physics as restricted. Bohr thought that quantum physics reproduced classical physics in the limit of large quantum numbers. Here are some other examples of the correspondence rule.

> Einstein's special theory of relativity reduces to classical mechanics when the limit of velocities is small compared to the speed of light.
>
> Einstein's general relativity reduces to Newtonian gravity in the limit when in the limit of weak gravitational fields.
>
> Kepler's theory of planetary movement is accurate when Laplace's theory of interplanetary interactions is ignored.
>
> Ptolemy's equations of coordinate systems reproduce Kepler's if the earth is stationary.
>
> When the number of particles is large, statistical mechanics reproduces thermodynamics.[59]

In the early 20th century, it was becoming evident that quantum physics violated five basic principles of classical science. Namely,

- Causality – Every event had a cause.
- Determinism – Every later state of a system is uniquely determined by an earlier state.
- Continuity – Any process evolves continuously from an initial state to a final state with intervening states.
- Conservation of Energy – The energy of a closed system can be transformed but it is never gained, lost, or destroyed.
- Locality – Physical objects are localized in space and time.[60]

During the years from 1925 to 1927 these major violations emanating in quantum physics caused quite a stir. Therefore, Niels Bohr, Werner Heisenberg, Max Born and others came up with a set of interpretations called the Copenhagen interpretation to try to give some definitive historical statements of the revolutionary ideas that were emerging but there were disagreements which turned out to not be so definitive. Here are some of the topics on how to interpret quantum mechanics in the Copenhagen discussions,

- Quantum mechanics is indeterministic. Only probabilistic results could be given by the Born rule.
- Quantum processes were intrinsically complementary. Complementary properties cannot be observed or measured at the same time.
- The act of observing or measuring a process is irreversible. No truth could be attributed to quanta except the results of a measurement.
- Quantum descriptions are objective in the sense that they are due to personal beliefs and arbitrary mental processes of physicists. [61]

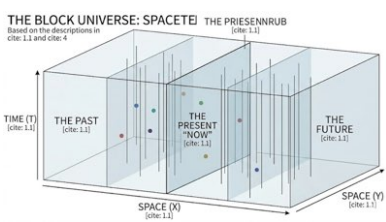
However, over the years there have been many objections to the Copenhagen interpretation which have made many of its interpretations arcane. For example, observation and measurement is apparently subjective requiring an observer. The observer effect is discontinuous and stochastic. Stochastic means a phenomenon has a certain amount of randomness, whereas it more strictly refers to a modeling approach. There is also more disagreement as to what constitutes a measuring device and the over-reliance on classical physics to define a measuring device. [62]

All of this said, everyone agrees that quantum physics has been the most successful scientific theory in the history of humanity, bar none!

First Look at Gravity as Geometry

We know from Einstein's theory of relativity that space *is* time and time *is* space. Space and time in Einstein's relativity is mathematically represented in four dimensions, three spatial dimensions and one time dimension. The four dimensions of space and time may as well be labeled w, x, y, and z from a mathematical point of view. This is called the 'block universe'.

> Einstein's statement was not merely an attempt at consolation. Many physicists argue that Einstein's position is implied by the two pillars of modern physics: Einstein's masterpiece, the general theory of relativity, and the Standard Model of particle physics. The laws that underlie these theories are time-symmetric — that is, the physics they describe is the same, regardless of whether the variable called "time" increases or decreases. Moreover, they say nothing at all about the point we call "now" — a special moment (or so it appears) for us, but seemingly undefined when we talk about the universe at large. The resulting timeless cosmos is sometimes called a "block universe" — a static block of space-time in which any flow of time, or passage through it, must presumably be a mental construct or other illusion.



The block universe is not how we experience space. In the

previous sentence I wrote ‘experience space’. I have implicitly assumed that experience means the passage of time. These normal and typical ways of thinking of space and time are not what space and time ‘*is*’. This way of thinking actually reflects habitual and repetitive ways through history which, before we even think about it, have accustomed us to simply and conservatively just assume this is simply the way it ‘*is*’. The seemingly short and filler word ‘is’ here almost goes without notice but brings with it much to say about who we are. More on that later.

The point of the block universe here is that, while we associate spacetime with phenomena given by ‘*is*’, general relativity amazingly describes spacetime mathematically as geometry. Geometry is the mathematics of shapes. Simple shapes like circles can be described with very simple formulas in two dimensions. A sphere can also be described with simple formulas as well in three dimensions. More complicated geometric shapes require more complicated mathematics and may require many dimensions to describe. Additionally, boundary shapes in geometric shapes can be explicitly described in multidimensional matrices. If you are familiar with spreadsheets like Excel, you can visualize matrices which can describe coordinates in multidimensional space which can easily be converted to geometric shapes and graphs. General relativity uses geometry to describe various complex shapes of spacetime. General relativity is very accurate. The Voyager probes used Einstein’s general relativity to escape the solar system by utilizing the spacetime curvature of planets to catapult them further and further into space greatly saving thrust and rocket fuel.

Einstein’s general theory of gravity in 1915 showed an essential connection with mass, the actual ‘things’ which make up ‘reality’ for us, and energy or what animates ‘things’. His general theory of relativity brought gravity into relativity. Gravity was shown to be the phenomenon of the bending of spacetime. The ‘bending of spacetime’ is geometric. Think of bending a piece of paper. These geometric bends of spacetime are what we think of as gravity.

Geometry plays a fundamental role in gravity and energy. Since energy is mass times the speed of light and the effect of mass in the geometry of spacetime is what we call the force of gravity, the common theme appears to be geometry. Geometrical shapes have a fundamental relationship to the universe we live and move and have our being in. The incomprehensible difference between geometry and the world we live in, from a commonsense point of view, is how we experience space and time as essentially separate phenomena from the mere geometry of spacetime.

Max Planck is considered the father of quantum theory. The word quanta are plural for discrete particles. The word quantum is singular for a particle. Relativity works very well for macro-phenomena like spacetime, planets, suns, etc. Classical physics fits very well into relativity as long as acceleration and the speed of light are not important factors. Relativity does not work well for smaller micro-phenomena. Quantum mechanics is now recognized as the most accurate model of the universe particularly for smaller scales. Quantum physics has been more rigorously investigated and tested than any other physical theory in history.

Geometry will be more important later when I discuss quantum gravity. We will get into quantum entanglement much more but for now here is a spooky fact - entanglement is very different from spacetime. Einstein's universe was finite. It was not expanding or contracting. We know now and even Einstein found out later that was wrong. Einstein's relativity assumed spacetime was smooth and continuous. Quantum physics shows us that spacetime is chunky and has mind blowing discontinuities. These discontinuities are so extreme that if you take the time to think about them you will see fractures which go well beyond physics into how we think about ourselves and our common-sense realities.

> Basically you can think of the division between the relativity and quantum systems as "smooth" versus "chunky". In general relativity, events are continuous and deterministic,

> meaning that every cause matches up to a specific, local effect. In quantum mechanics, events produced by the interaction of subatomic particles happen in jumps (yes, quantum leaps), with probabilistic rather than definite outcomes. Quantum rules allow connections forbidden by classical physics. [64]

Einstein's four papers of special relativity in 1905 and Einstein's 1915 theory of general relativity together with quantum mechanics are the foundation of modern physics. One more thing to note here is that not everything in quantum theory is quantized. Let's take a closer look at quantum mechanics.

Quanta are Both Wave and Particle

Quantum particles are not just extremely small, solid pieces of matter. They behave both like extremely small, point-like, solid pieces of matter and like waves depending on the way an experimenter sets up the experiment to look at them. The dual nature of quantum particles as both particle and wave is also another source of uncertainty. Werner Heisenberg (1901-1976) discovered that the path a particle is traveling on, and the momentum also has a duality. In order to start this discussion, I want to first look at some basics in classic mechanics to provide some background to this discussion.

Classic Mechanics

From Newtonian mechanics,

Force is the rate at which momentum changes over time. This is mathematically symbolized as,

F = dp/dt, think of 'dp' as the change or **d**ifference in momentum (p) divided by the time (t) span in which the momentum changed (dt).

Additionally, when a fixed mass is moving momentum is equal to the mass times the velocity. This is mathematically symbolized as,

p = mv where ‘p is momentum, ‘m’ is mass, and ‘v’ is velocity.

So, in the previous formula,

F = dp/dt we substitute for ‘mv’ for ‘p’ and assume sub-light speeds where mass does not change, we get:

F = m times dv/dt or Force is equal to mass times (X) the change in velocity (dv) divided by the change in time (dt) but since the change in velocity divided by the change in time is acceleration (a), we get,

F = ma or Force equals mass times acceleration. [65]

From this we know that,

- Force is related to the change in momentum divided by the change in time,
- Force is mass times the change in acceleration.
- Momentum is a measure of an object's '**mass in motion.**' All objects have mass, but only moving objects have momentum. Momentum measures the 'motion content' of an object and is based on the product of an object's mass and acceleration. Momentum doubles, for example, when acceleration doubles. Similarly, if two objects are moving with the same acceleration, one with twice the mass of the other will have twice the momentum.

The force of a moving particle is related to an object’s mass times the change in the mass’ acceleration. Acceleration is a result of translational and rotational motions. Therefore, acceleration also has directions. Acceleration is a vector of changing speed in particular directions. The translational and rotational magnitudes can be summed in terms of total magnitude and direction of the particle’s path. All of this is to say simply that we can think of the force of a particle as the change of momentum of the particle in

time and that boils down to the force of a particle is equal to the particle's mass times its acceleration or F = dp/dt = ma. [66]

A freight train has a lot of momentum which makes it hard to slow down very fast. But we can measure both the momentum and the position of a freight train at the same time. This is not true of the quantum world.

Quantum Mechanics

Heisenberg discovered that in the quantum world the path and the momentum are impossible to measure at the same time. The more certain you are of the path, the less certain you will be of the momentum and *vice versa*. This is called Heisenberg's Uncertainty Principle.

> "At the instant of time when the position is determined, that is, at the instant when the photon is scattered by the electron, the electron undergoes a discontinuous change in momentum. This change is the greater the smaller the wavelength of the light employed, i.e., the more exact the determination of the position. At the instant at which the position of the electron is known, its momentum therefore can be known only up to magnitudes which correspond to that discontinuous change; thus, the more precisely the position is determined, the less precisely the momentum is known..." [67]

From a correspondence foreshadowing Einstein's 1935 EPR paper Einstein tells us,

> Thus without an experiment on m [momentum] it is possible to predict freely, at will, either the momentum or the position of m with, in principle, arbitrary precision. This is the reason why I feel compelled to ascribe objective reality to

both. I grant, however, that it is not logically necessary. [68]

This is very different from the classical world we are all accustomed to. Let's look at a photon, a quantum particle of light. As a wave, light is a form of electromagnetic radiation, a wave packet. Visible light is made up of multiple frequencies. A single photon has one frequency. Light is composed of multiple quantum particles called photons and are discrete packets of energy. [69] Light is both particle and wave depending on how an experiment is set up to look at them. Electrons also are waves which like photons have incessant influxes and outfluxes of wave energy which transform themselves into and out of existence from vacuum energy to be discussed more later.

> In modern physics, the double-slit experiment demonstrates that light and matter can satisfy the seemingly-incongruous classical definitions for both waves and particles, which is considered evidence for the fundamentally probabilistic nature of quantum mechanics. This type of experiment was first performed by Thomas Young in 1801, as a demonstration of the wave behavior of visible light. At that time it was thought that light consisted of either waves or particles. With the beginning of modern physics, about a hundred years later, it was realized that light could in fact show both wave and particle characteristics. In 1927, Davisson and Germer and, independently George Paget Thomson and Alexander Reid demonstrated that electrons show the same behavior, which was later extended to atoms and molecules. Thomas Young's experiment with light was part of classical physics long before the development of quantum mechanics and the concept of wave–particle duality. He believed it demonstrated that Christiaan Huygens' wave theory of light was correct, and his experiment is sometimes referred to as Young's experiment or Young's slits.

70

This brings us to one of the most famous and perplexing experiments in physics history – the double-slit experiment. The spookiness as to how an observer measures wave/particle duality determines what will be seen – wave or particle. This not only applies to light but to all quanta including electrons and even atoms and molecules have been proven to have this spookiness so far with up to 2,000 atoms. 71 How can molecules and atoms look like quanta? More on that later but for now it is because they are entangled systems.

The Single-slit and Double-Slit Experiment

> Few science experiments are as strange and compelling as the double-slit experiment.
>
> Few experiments, if any, in modern physics are capable of conveying such a simple idea—that light and matter can act as both waves and discrete particles depending on whether they are being observed—but which is nonetheless one of the great mysteries of quantum mechanics. 72

But it gets weirder,

> But not only has the double-slit experiment been repeated countless times in physics labs around the world, but it has also even spawned many derivative experiments that further reinforce its ultimate result, that particles can be waves or discrete objects and that **it is as if they "know" when you are watching them**. 73

All quanta vibrate and jitter. The vibration and jitter never stop. When quanta have more energy, they vibrate faster and when they have less energy, they vibrate slower. Visible light is composed of

multiple photons all vibrating and jittering at different frequencies. Having multiple frequencies increases complexity so the experiments below use quanta like photons and electrons which only vibrate and jitter at one frequency. This is called a 'coherent' source. The double-slit experiment is a historic milestone in quantum physics that demonstrates quanta can satisfy two contradictory definitions as both wave and particle. It is considered to be the first evidence for the fundamentally probabilistic nature of quantum mechanics.

> In modern physics, the double-slit experiment demonstrates that light and matter can satisfy the seemingly-incongruous classical definitions for both waves and particles, which is considered evidence for the fundamentally probabilistic nature of quantum mechanics. 74

Think about this seemingly-incongruous classical definitions for both waves and particles. In plain English, it's like discovering that your Mac Studio is simultaneously a high-end computer and a bag of sand, depending on when you open the case.

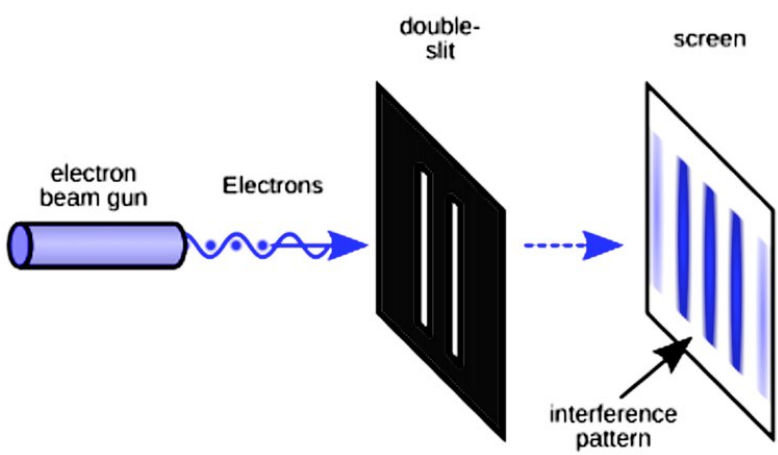
Here is a brief description of the double-slit experiment.

> In the basic version of this experiment, a coherent light source, such as a laser beam, illuminates a plate pierced by two parallel slits, and the light passing through the slits is observed on a screen behind the plate. The wave nature of light causes the light waves passing through the two slits to interfere, producing bright and dark bands on the screen – a result that would not be expected if light consisted of classical particles. 75

If photons were made up of individual particles, they would not interfere with each other. They would simply go through the slits, and many would hit the screen as a point. Some might veer too

close to the edge of the screen and get deflected by varying amounts showing up on the screen as lighter and lighter points around the central points. This is called a diffraction pattern. This is because the further they veer off, the less the number of point-like particles would hit the screen. But this is not what the screen pattern looks like with two slits. With two slits the pattern looks like two waves coming through each slit causing a wave-like interference pattern on the screen. This demonstrates the particle/ wave duality of quanta.

The double-slit "*experiment belongs to a general class of "double path" experiments, in which a wave is split into two separate waves (the wave is typically made of many photons and better referred to as a wave front, not to be confused with the wave properties of the individual photon) that later combine into a single wave.*" [76] The diagram below shows two slits. When an electron beam is sent through the two slits, they make a pattern on the screen located behind the slits which reflect interference patterns indicating they are arriving like waves on a beach. Have you ever noticed the regular patterns of undulating sand in long rolls under the water on the edge of the surf at a beach? That is an interference pattern made by the turbulence of the water as constructive and destructive wave amplitudes wash up on the beach.



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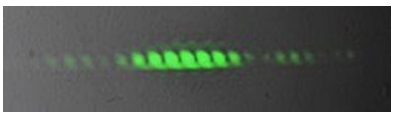
Photons or matter (like electrons) produce an interference pattern when two slits are used.



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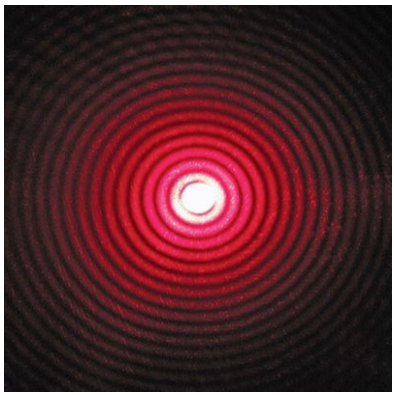
Light from a green laser passing through **two slits** 0.4mm wide and 0.1mm apart 79

In the case of a single circular slit shown below, the electrons act like single particles or coherent rays hitting the screen eventually accumulating in a diffraction pattern from the center of the screen outwards. The single slit circular image on the screen below reflects the shape of the slit as a bright center circle on the screen. Most of the electrons pass straight through the circular slit without encountering the edge of the slit causing a higher intensity circle in the center of the screen. However, some of the electrons are deflected by the atomic fields which make up the edge of the circular slit causing them to veer off with lower intensity circular bands away from the center of the screen. This is called diffraction. This is how classical science and commonsense would tell us it should work.

> In classical physics, the diffraction phenomenon is described by the Huygens–Fresnel principle that treats each point in a propagating wavefront as a collection of individual spherical wavelets. The characteristic bending pattern is most pronounced when a wave from a coherent source (such as a laser) encounters a slit/aperture that is comparable in size to its wavelength, as shown in the inserted image. This is due to the addition, or interference, of different points on the

wavefront (or, equivalently, each wavelet) that travel by paths of different lengths to the registering surface. [80]

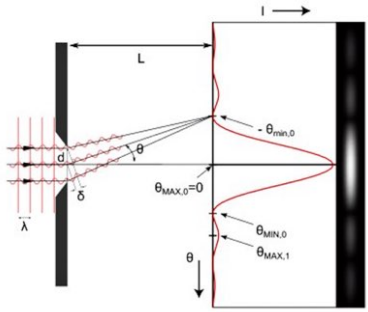


[81]

A diffraction pattern of a red laser beam projected onto a plate after passing through a small circular aperture in another plate. [82]

The size of the pattern on the screen is dependent on the opening that the electrons go through.

The amount of diffraction depends on the size of the gap. Diffraction is greatest when the size of the gap is similar to the wavelength of the wave. In this case, when the waves pass through the gap they become semi-circular. [83]

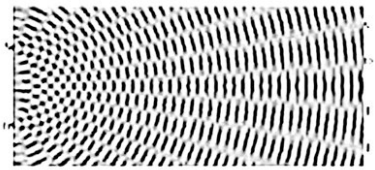


84

This is a common wave-like diffraction pattern that happens with any kind of wave.

> These effects also occur when a light wave travels through a medium with a varying refractive index, or when a sound wave travels through a medium with varying acoustic impedance – all waves diffract, including gravitational waves, water waves, and other electromagnetic waves such as X-rays and radio waves. Furthermore, quantum mechanics also demonstrates that matter possesses wave-like properties and, therefore, undergoes diffraction (which is measurable at subatomic to molecular levels). 85

In 1801 Thomas Young (1773–1829) described the double-slit interference wave using water waves with the sketch shown below. At that time, it was believed the light was composed of either wave or particle but not both wave and particle. 86



Young's drawing of diffraction [87]

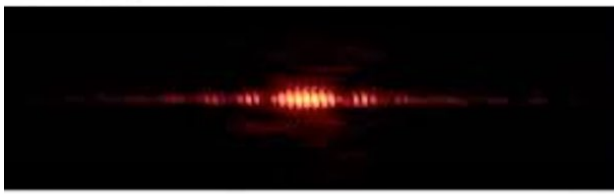
> When Thomas Young (1773–1829) first demonstrated this phenomenon, it indicated that light consists of waves, as the distribution of brightness can be explained by the alternately additive and subtractive interference of wavefronts. Young's experiment, performed in the early 1800s, played a crucial role in the understanding of the wave theory of light, vanquishing the corpuscular theory of light proposed by Isaac Newton, which had been the accepted model of light propagation in the 17th and 18th centuries. [88]

If there are multiple, closely spaced openings (e.g., a diffraction grating), a complex pattern of varying intensity can result. [89] Young's experiment reflected sunlight with a small mirror through two holes in a card to show how light splits into two beams creating the interference pattern. [90]

The first picture below shows a single-slit diffraction pattern. The screen for the single-slit experiment shows a diffraction pattern in which single particles or rays accumulate on the screen. Visualize this as a one-dimensional, point-like ray hitting the screen. The second picture below shows a double-slit interference pattern. The screen for the double-slit experiment accumulates a wave interference image on the screen. Think of this as a three-dimensional surf of waves hitting the screen.

> However [for a single-slit], the light is always found to be absorbed at the screen at discrete points, as individual particles (not waves); the interference pattern [for two slits] appears via the varying density of these particle hits on the screen. [91]

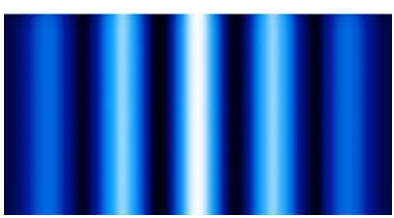
Laser light passing through a single slit, showing basic diffraction pattern.



Double-slit pattern. Note the interference fringes, on top of the diffraction pattern.

92

The next picture below shows a double-slit interference pattern experiment without any photon detectors located on the slits. When the photon wave hits the two slits, each slit acts as a separate source of two photon waves which interfere with each other after they pass through the slits. This is what we normally expect of a wave passing through two slits. This is a normal interference pattern where the photon waves are in a state called superposition which will be discussed much more later.



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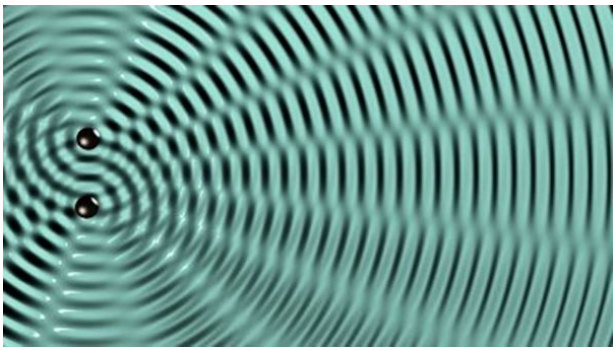
However, different from a single slit, this double-slit pattern has

contour, width and depth, like surf crashing on the beach or the picture below.

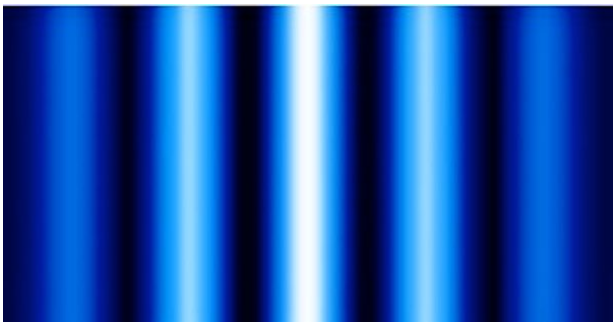


94

The next picture below shows a double-slit experiment with one photon detector, an observer, in *front* of one of the slits. In this case the photon detector lights up 50% of the time as would be expected with one detector. The detector has collapsed the superposition state into a particle pattern meaning there is no interference pattern. Each slit, even the one without the photon detector, makes single slit diffraction patterns on the screen. Even if the detector is set up *behind* one of the double-slits the same dual single-slit particle pattern emerges. In this case, it means the superposition interference pattern ***apparently*** enters each double-slit and is converted or collapsed into the particle pattern when it encounters the detector on the other side of the slit. This defies the intuitive notion of time that we have. But subsequently it was discovered that the detector 'collapsed' the wave pattern before it ever encountered the detector. Additionally, there is another time problem indicated in this case because the slit without the photon detector somehow 'knows' there is a photon detector simultaneously on the other slit. This will be discussed in more detail later, but it is as if the effect came from a cause in the future. It is as if the photons knew from its very origin at the laser that it

was being observed. This is called retrocausality.

If two photon detectors are used on each slit the same particle pattern emerges with each photon detector lighting up 50% of the time. This is what quantum physics calls the observer effect.



95

> Furthermore, versions of the experiment that include detectors at the slits find that each detected photon passes through one slit (as would a classical particle), and not through both slits (as would a wave). 96
>
> However, such experiments demonstrate that particles do not form the interference pattern if one detects which slit they pass through. These results demonstrate the principle of wave–particle duality. 97

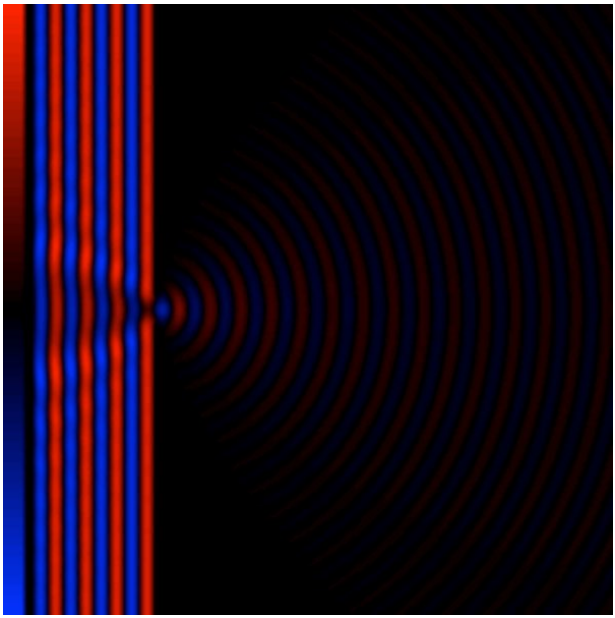
The spooky thing about this is that when one photon detector observes the wave interference pattern on one slit, it is as if the waves crashing on the beach bizarrely and instantly transform the whole wave-like environment into two beachballs falling from the sky onto the beach. Even if two photon detectors, observers, are placed on each of the two slits, the interference pattern goes away, and the electrons behave as particles going through each slit. It is as if the photon waves know *a-temporally* that someone or something is watching them.

Visualize this, you shoot a steady stream of single photons slowly at a single-slit without any detector. These photons are shot in varying directions, so they do not always go directly through the middle of the slit. The photons that go through the single-slit accumulate on the screen resembling the bright center region on the screen with less probable particles getting dimmer and dimmer as they get further from the bright center spot. This is what you would expect to see for particles. Think about it like this, make believe photons are pea-sized paintballs, if you continuously shoot the paintballs through one larger vertical slit, you will eventually see a line of paint representing the shape of the slit where some of the paintballs went straight through like the single-slit pattern above. Some of the paintballs hit the edge of the slit as they passed through causing them to veer further out from the center bright image. How far they veer out is dependent on how much of the paintball touches the edge of the slit or in the case of photons how the width of the slit compares to the wavelength of the photon. This is classic particle physics. [98] It is intuitive.

Single-slit Diffraction

Some photons are bent more than others at the edges of the slit. The wave around the edges of the slit gets bent outwards. The smaller the slit relative to the frequency of the photon, the more the wave gets bent outwards. The larger the slit relative to the frequency of the photon, the less the wave gets bent outwards. Actually, this is related to the wavelength of the photon's frequency and the size of the slit. The wave patterns of single-slit diffraction can be fully described by classic physics which predate quantum physics.

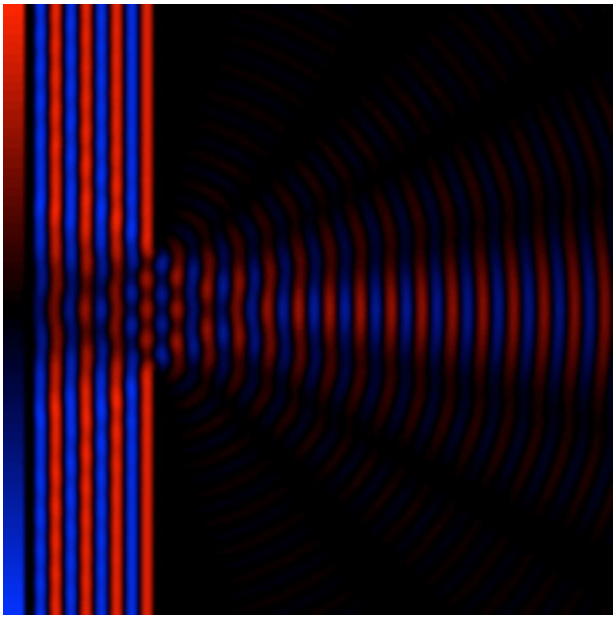
If the single-slit is smaller compared to the wavelength of the photon, the picture below shows the diffraction pattern spreading out further.



99

Note: If the animation does not work click on the link in the footnote.

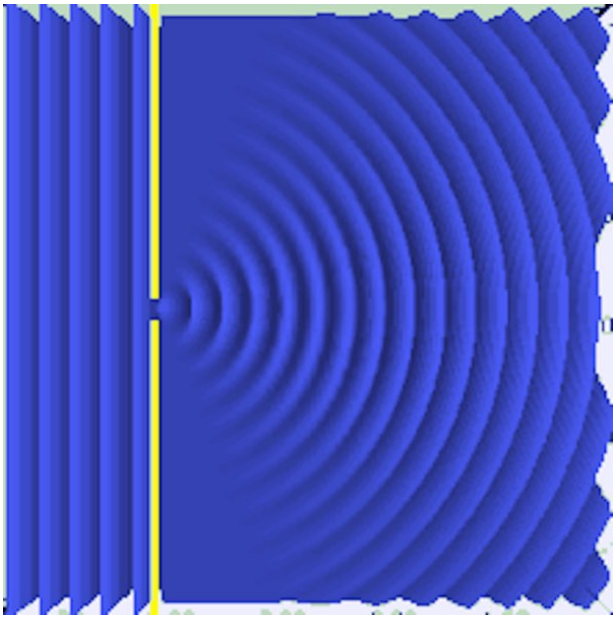
If the single-slit is large compared to the wavelength of the photon, the picture below shows the diffraction pattern spreads out closer.



[100]

Note: If the animation does not work click on the link in the footnote.

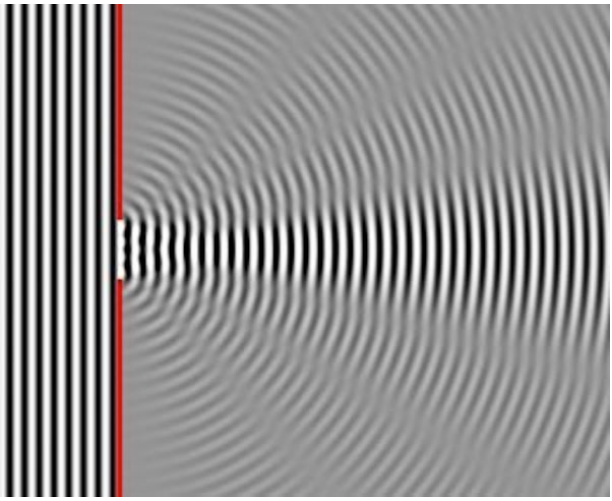
If the length of the single-slit is equal to the wavelength of the photon the diffraction pattern looks like the picture below. Notice how the crests and troughs move away from the center on the right side where the screen is situated. This pattern causes a more random scattering of the photons, getting more blurred images on the screen.



[101]

Note: If the animation does not work click on the link in the footnote.

If the length of the single-slit is equal to four wavelengths of the photon the diffraction pattern looks like the picture below. Note that when multiples of the wavelength are set to widths of the slit size the pattern has more of a symmetry.

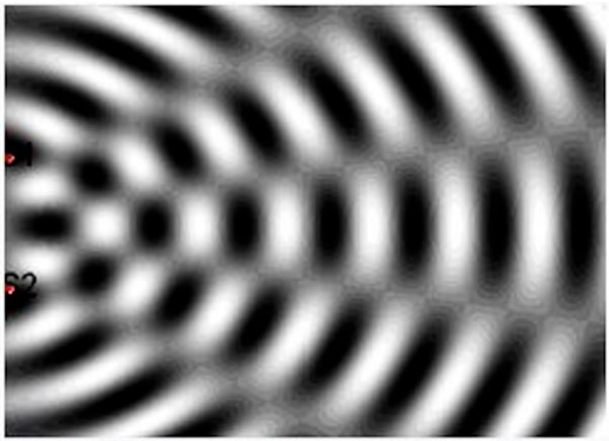


Double-slit Diffraction

If we have two large paintball slits without any detectors. When we shoot many paintballs through them, the pattern we see does not resemble the shape of the slits with some veering out after they hit a slit edge. Oddly, we imagine the paintballs went into the slits as if they were streams of paint waves being shot through the slits. We know we shoot discrete paintballs, but they no longer looked or acted like discrete paintballs. They acted like streams of paint waves going through the slits. This creates interference patterns on the screen with some paint waves adding to the screen amplitudes and some paint waves canceling out the screen amplitudes. This makes the screen look more like a three-dimensional surface of paint waves frozen in time on the canvas. These double-slit wave patterns can be described in superposition using the quantum wave function.

Double-slit Interference Pattern of Wave

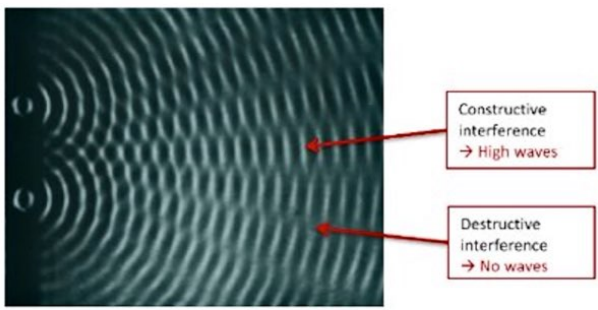
103



Wave interference in water due to two sources marked as red points on the left.

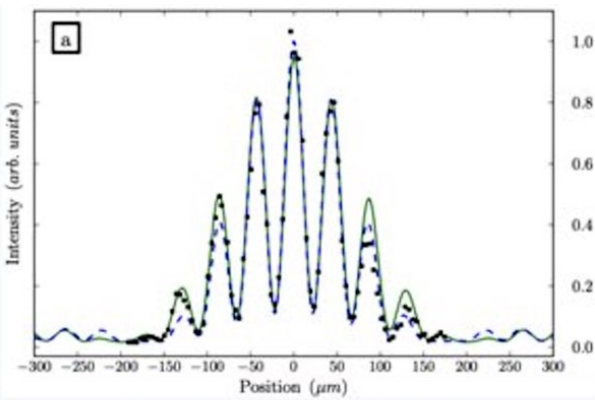
104

Don't forget the double-slit interference pattern takes place in three-dimensions as a field. Below is a water representation of how that might look.



Double-slit with water (wiki.anton-paar.com)

Here you can see how the amplitude of the three-dimensional wave interference pattern peaks and then drops off. On the two-dimensional screen image, you only see that as wave peaks and troughs getting dimmer and dimmer.



Line trace for a two-slit electron interference pattern. Compare to a slice through the image of the water wave pattern above.

Ok, we have recently seen two odd things about quantum particles,

- For quanta, we cannot measure momentum and position of a particle at the same time.
- Quanta is both particle and wave.

This makes no sense in our commonsense world but whether we like it or not makes total sense in the quantum world. In our commonsense world we are told, and we naturally think, a baseball cannot be a football and a football cannot be a baseball. Things are separate and have identities which are maintained. One would have

to be a nut to think differently because our commonsense world tells us that to think ‘a baseball is a football’ is a contradictory statement, a contradiction in terms, in identities. To add insult to injury now we are told that the quantum world is not only contradictory but spooky too. What are these physicists smoking?

I will discuss what follows in much more detail later but for now what is really happening in the two-slit experiment without detectors is:

- When we see the two-slit wave interference pattern, quanta or molecules are in a superposition state. This means they are not localized as a particle but spread out like a wave.
- When we see the one-slit particle pattern, quanta or molecules have collapsed out of superposition. This means that they are localized as a particle.

Now if we add one detector on one slit or two detectors on each slit, classic wave mechanics cannot describe the resulting pattern on the screen. [108] The resulting pattern is not wave-like but particle-like. With the detector instead of the wave-like pattern we expected to see, we actually see the particle-like pattern - simply because we are observing them with our detector. The classic idea we have of waves passing through the slits does not happen as expected when we observe them. In this case, the particle pattern strangely appears as if we were only using discrete paintballs and not streams of paint. Classic physics cannot explain this phenomenon. But the quantum wave function can. I will get into that later.

A Brief Summary

Single-slit particle patterns are called diffraction patterns.

Diffraction is caused by the bending of particles around small openings. Double-slit wave patterns are called interference patterns. What is the difference between the single-slit diffraction and the double-slit interference patterns? [109]

Single-slit Particle Pattern

- The single-slit pattern is localized.
- This is classic mechanical particle physics.
- The single-slit particle ray is continuous. This can be thought of as a single, smooth, and uninterrupted ray passing from one side of the slit to the other side of the slit.
- The single bright center blurred image on the screen and the dimmer sidebands are caused by most rays passing straight through the slit and others being diffracted out as they pass through the slit.
- The single-slit image on the screen has no width or depth. It is a flat image.
- The screen pattern has less intense sidebands having less and less energy as they spread out around the brighter larger center image which has much more energy.
- The non-classical quantum wave function can describe this as well.

Double-slit Wave Interference Pattern (no detection)

- The double-slit wave pattern is not localized. It is spread out like a wave.
- This is classic mechanical wave function physics.
- The double-slit wave is continuous. Perhaps this could be thought of as a field of waves.
- The screen pattern has interference patterns which reflect

the crests and troughs as they pass through the slit.
- The double-slit pattern on the screen is more like a multi-dimensional field having both width and depth.
- The interference pattern, the field strength, gets less and less in amplitude in a smooth pattern-like fashion as they spread out around the larger center interference pattern.
- The non-classical quantum wave function can describe this as well.

Double-slit Wave Interference Pattern with detection

- This is like the "Single-slit Particle Pattern" except with two slits instead of one slit.
- The non-classical quantum wave function can describe this behavior as well, but the classical wave function cannot describe this behavior.
- Ok, one more thing, we do not know exactly when or where the photon detector, the observer, changed the double-slit wave interference pattern into the single-slit ray diffraction pattern. We know the observation changed the double-slit interference pattern into a single-slit particle pattern but when the pattern changed cannot find a 'present' to our commonsense notion that every 'present' has a past and future action or cause. More on that later. As Lewis Carroll was fully aware, we are way down the rabbit hole now!

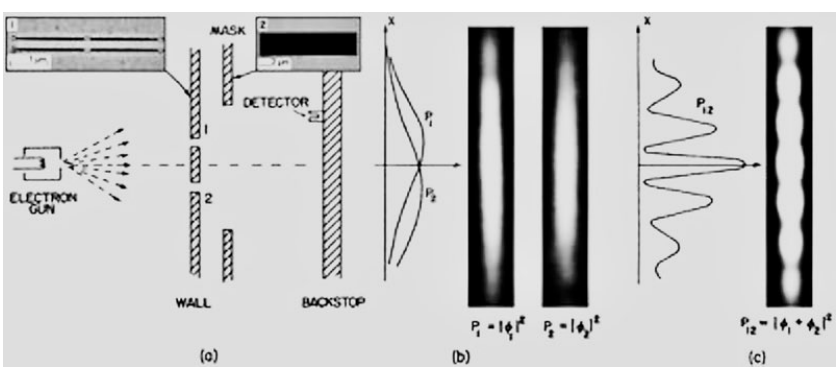
An Experiment Showing Both Single-slit and Double-slit Patterns

An interesting setup of the double-slit experiment was published in the "New Journal of Physics" in 2013. [110] An electron beam was used to send electrons through slits. This experiment used a movable mask in front of the double slits which initially blocked both slits. As the mask moves one slit is exposed, eventually both

slits are exposed, and eventually the other slit is exposed. A photon detector can be used ***intermittently*** to detect an electron passing by the detector which intermittently collapses the superposition pattern into a particle state pattern.

One thing to note is how a photon detector is used to detect an electron's change in energy. A photon detector can be used to detect an electron passing by a detector because the electron in its wave-like state can interfere with itself and create a pattern of constructive and destructive interference which averages out as a certain level of energy. When an electron collapses into a particle state it loses energy because it always releases a photon in the transition from wave to particle. The photon detector then detects this energy drop, which indicates that an electron particle minus a photon has passed by the detector.

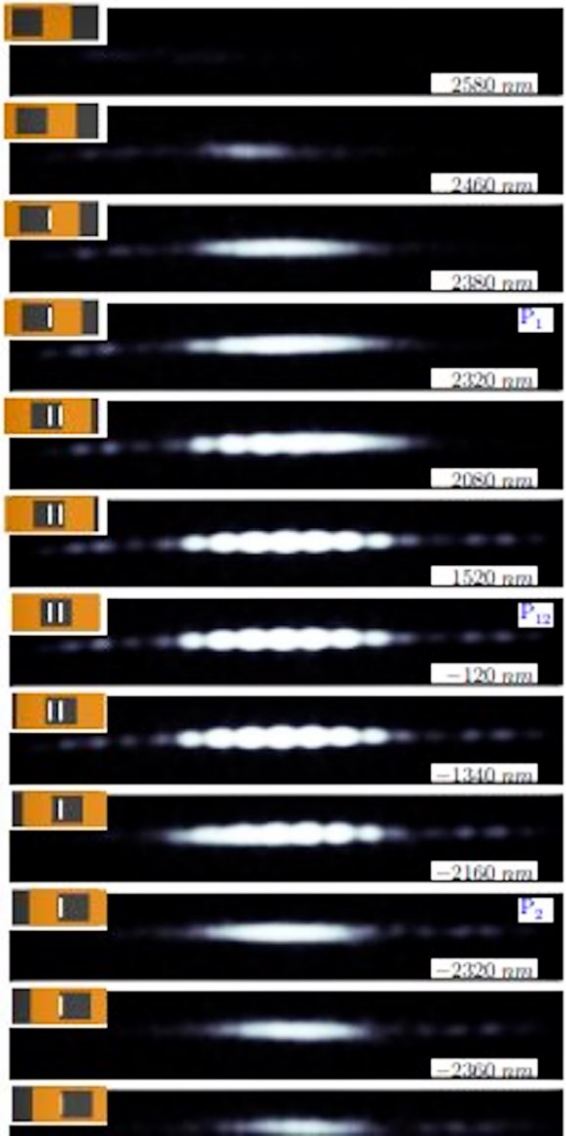
The diagram below shows an experimental setup which allows a mask to cover one of the slits allowing only a single-slit pattern shown at (b). Notice the smooth continuous wave pattern for the single slit. When both slits are open, we see the wave interference pattern shown at (c). Notice the chunky, discrete pattern of the wave interference pattern. If a detector is occasionally turned on and used to detect the quanta passing through the double-slits, the superposition state collapses into a particle state illustrated by the single-slit pattern. This is called the observer effect of the quantum wave function.



A movie of the experimental setup can be found at this footnote. [112] “Movie 1”, shows how the movable mask moves over the slits. A detailed description of the setup, “Supplemental Setup” [113] can also be found there. “Movie 2” and “Movie 3” [114] show the results on the screen as the mask moves exposing single slits or both slits. The movie below also shows the results.

The top images on the diagram below are not used with the photon detector turned on. The mask moves (shown on the top left of the top images) from left to right exposing one slit, then two slits, then one slit again. Because of this the images at the top of the diagram below show the normal particle pattern with one slit changing to the normal wave pattern with two slits and then back again to the normal particle pattern with only one slit exposed. We can see the particle pattern when the electrons are allowed to pass through one slit. We can see the wave interference pattern when the electrons are allowed to pass through two slits without detection.

Having observed wave behavior, now we change the experiment, lowering the intensity of the electron source until only one or two are detected per second, appearing as individual particles, dots in the video. As shown in the bottom movie clip below, the dots on the detector seem at first to be random. After some time, a pattern emerges, eventually forming an alternating sequence of light and dark bands which give us a ghostly image of the wave interference pattern.


2580 nm
2460 nm
2380 nm
P1
2320 nm
2080 nm
1520 nm
P12
−120 nm
−1340 nm
−2160 nm
P2
−2320 nm
−2460 nm

[116]

Note: If the animation does not work click on the link in the footnote.

The time lapse of single dot patterns over time does not reveal a random scattering of dots but a ghostly image emerges of a wave interference pattern. This experiment is a clear case of how quanta are both wave and particle. If you want to see a larger quick video of how the interference patterns accumulate on the screen watch this:

Video of how the interference pattern accumulates

There are many other experiments which validate the wave/particle enigma. The Mach-Zehnder interferometer experiment at the link below shows a video of how superposition displays a 50% chance of hitting one photon detector and a 50% chance of hitting a second photon detector and when one path of photons is blocked the superposition collapses into one value where 100% of the photons go to only one photon detector.

Mach-Zehnder interferometer Video

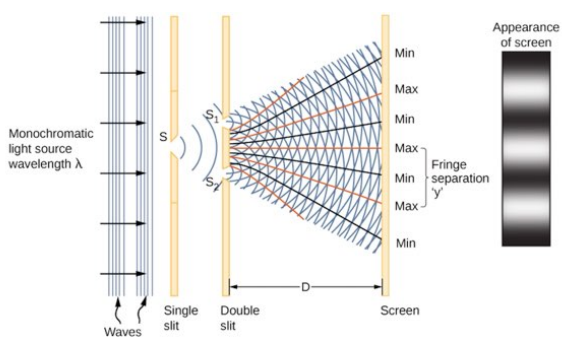
Over the years many more experiments have proven conclusively the wave/particle duality and superposition/collapse in quite ingenious and illuminating ways here: Double-slit

experiment

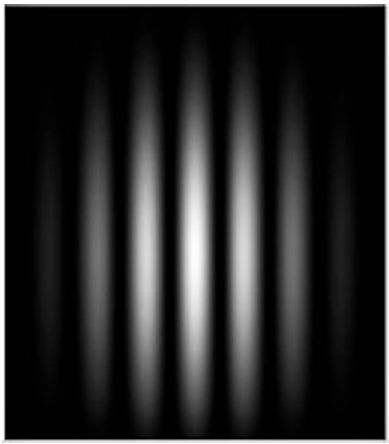
The uncertainty principle tells us that at the most fundamental level of 'existence' there is no fundamental certainty as to whether quanta is wave *or* particle. The cohesive reality is an absolute contradiction which cannot be resolved. It does not give way to a higher unity but nevertheless 'is' in a very spooky way without resolve. There is a spooky observer effect which I will get into more in the coming section, "The Quantum Wave Function." For now, I want to offer a prelude to that section.

A Deeper Dive – An Example for Calculating the Probability Density for a Double Slit Waveform

From the previous discussion of the two-slit experiment let's recall that light composed of photons is an electromagnetic wave. The classical wave function of light in terms of energy tells us that the energy field strength is a function of position and time, or E(x,t) and energy density is given by the square of energy or $|E|^2$. The energy of an individual photon depends on its frequency. This means $e_{photons} = hf$ where 'h' is the Planck constant, and 'f' is the frequency. This implies that $|E|^2$ is proportional to the number of photons. The minimum and maximum interference patterns are caused by constructive and destructive interference. This is true of many different kinds of wave/particles.

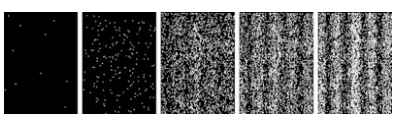


117



118

But even when detection is done slowly, we still see an interference pattern slowly emerge.



119

The square of the quantum wave function in one dimension has a similar interpretation to the square of the electric field. The quantum wave function gives us a probability density that the position of a particle upon classical state reduction, collapse, will be found at a particular length and a time per unit length. This is called probability density. This implies the probability density of a particle found in a region between x and x + dx (the change in distance) is equal to the change in distance, dx, times the amplitude squared of the wave function or if the wave function varies slowly over the interval of x,

$$P(x, x+dx) \approx |\Psi(x, t)|^2 dx$$

If the wave function does not vary slowly the use of calculus integration is required. Integration simply requires finding the area under a highly irregular waveform. The integration simply adds up tiny slices of area to get the total area. The smaller the slices, the more accurate the end result. In the case of probability density, a more irregular and complex density area would require integrating over the area of interest to get a more accurate probability density. Integration over more dimensions would simply require integration over all the dimensions. [120]

$$P(x, x+\Delta x) = \int \ldots$$

Wave/Particle Properties

Particles do not just have a point-like property for where they might be located. They also have other intrinsic properties like spin, momentum, energy, charge, and angular momentum.

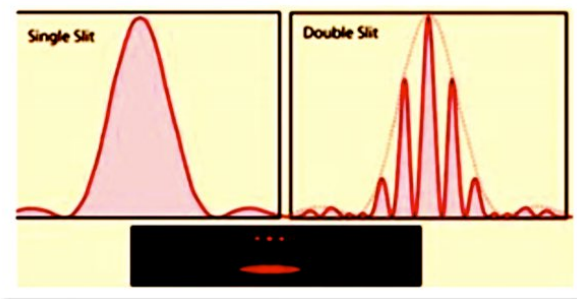
- Spin is an intrinsic form of angular momentum carried by elementary particles, and thus by composite particles such as hadrons, atomic nuclei, and atoms. Spin should not be conceptualized as involving the "rotation" of a particle's "internal mass", as ordinary use of the word may suggest spin is a quantized property of waves.
- Momentum is a fundamental concept in quantum mechanics. It is a measure of the motion of a particle and is related to its velocity and mass. Momentum is a vector quantity, meaning it has both magnitude and direction.
- Energy is another fundamental concept in quantum mechanics. It is a measure of the ability of a particle or system to do work. Energy can take many forms, such as kinetic energy, potential energy, and rest energy.

- Charge is a property of some particles that determines how they interact with electric and magnetic fields. Particles can have positive, negative, or zero charge.
- Angular momentum is another intrinsic property of particles that describes their rotational motion around an axis. It is related to the particle's position and momentum.

This will be discussed more later.

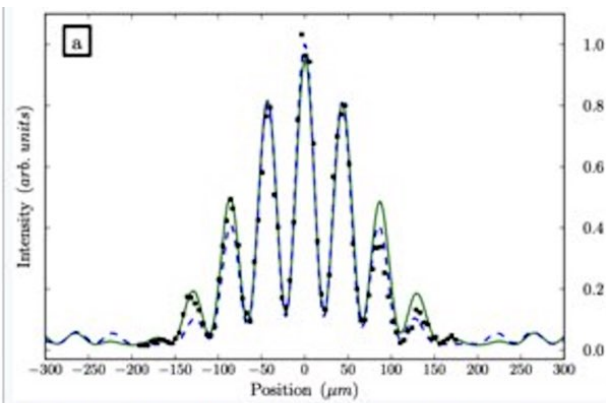
A Deeper Dive – Energy and Momentum

In the diagram below, the pattern of the double slit and the single slit reflect the intensities of their energy corresponding to the peaks seen in the diagrams. In the diagram below on the upper left we see the diffraction pattern due to a single slit. The pattern on the center image in the bottom shows the single slit pattern on the screen. The width of that pattern is controlled by the slit width. In the double slit arrangement, the diagram below on the upper right shows the diffraction patterns from each slit overlap and an interference pattern is produced whose intensity is modulated by the diffraction pattern due to each single slit. The pattern on the right side of the image ("Double Slit") shows the double slit interference pattern on the screen. The separation of the interference fringes depends on the slit separation. If the slit width is increased the width of the diffraction envelope is decreased while the separation of the interference fringes stays the same. So, less interference fringes will be visible.



122

The single-slit continuous wave particle's energy pattern changes around the fundamental frequency.



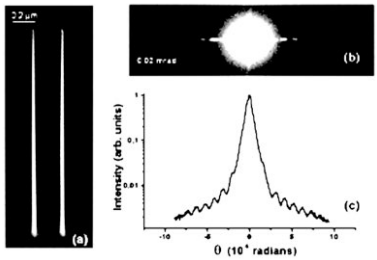
Line trace for a two-slit electron interference pattern. Compare to a slice through the image of the water wave pattern above.

123

A graph of single-slit diffraction intensity showing the central maximum to be wider and much more intense than those to the sides. In fact, the central maximum is six times higher than shown here. 124

Here is how the energy intensity of the double-slit, without detectors, interference pattern changes around the fundamental

frequency.



125

A double slit (a), interference pattern (b), and intensity plot (c), from S.Frabboni, G. C. Gazzadi, and G. Pozzi, “Young’s double-slit interference experiment with electrons,” Am. J. Phys. 75(11), 1053–1055 (2007),126

The intensity of the single slit shows the energy and diffraction pattern of a single ray or wavelet at a set frequency. However, for the double-slit experiment what is meant by ‘frequency’ is trickier. In any case as already discussed, quantum mechanics had its early beginnings in two simple formulas. One formula comes from Einstein and the other formula comes from Louis de Broglie (1892-1987). Einstein’s formula was,

$E = hf$ where ‘E’ is energy, ‘h’ is Planck’s constant, and ‘f’ is frequency.

De Broglie’s formula was,

$P = h/\lambda$ where ‘p’ is momentum, ‘h’ is Planck’s constant, and λ (lambda) is wavelength.

And Planck’s energy constant is,

$$h = 6.63 \times 10-34 \text{ J s} = 4.14 \times 10-15 \text{ eV s}$$

As I discussed in the previous section “Why Planck”, we saw that ***energy is to time (period of frequency) as momentum is to space (wavelength of frequency)***. This relationship also applies to angular frequency and angular wave number which is used more often in quantum physics.

The similarity of the Einstein and de Broglie relations becomes more apparent if we express the former in terms of the period of the wave, $T = 1/f$: $E = h/T$ and $p = h/\lambda$. In other words, energy is to time (period) as momentum is to space (wavelength). Alternatively, we can write these relations in terms of the angular frequency, $\omega = 2\pi f = 2\pi/T$, and the angular wavenumber, $k = 2\pi/\lambda$. For convenience, we usually absorb the factors of 2π into Planck’s reduced constant, $\hbar = h/2\pi = 1.05 \times 10-34$ J s $= 6.58 \times 10-16$ eV s (pronounced “h bar”), so we have simply $E = \hbar\omega$ and $p = \hbar k$.

Let’s remember that in classic mechanics position and momentum are all we need to describe the initial conditions and path of an object. In quantum physics we need the quantum wave function. The idea here is that energy is to time as momentum is to space.

Superposition and Particle

The images below show the relationship of the screen image to a slow stream of single particles going through the double-slit, one particle at a time eventually accumulating as an interference pattern.

> An important version of this experiment involves single particle detection. Sending coherent particles through a double-slit apparatus one at a time results in single particles being detected as white dots on the screen, as expected. Remarkably, however, an interference pattern emerges when these particles are allowed to build up one by one (see the

image below).

127

128

129

Note: If the animation does not work click on the link in the footnote.

Experimental electron double slit diffraction pattern. Across the middle of the image at the top the intensity alternates from high to low showing interference in the signal from the two slits. Bottom: movie of the pattern buildup dot by dot. Click on the thumbnail to enlarge the movie. 130

In the previous section entitled “An Experiment Showing Both Single-slit and Double-slit Patterns”, we saw how detecting one photon at a time intermittently produced a single dot on the screen like a particle but over time produced an image of the double-slit, interference pattern. It was as if somehow the single dots were really in a ghostly fashion in the interference wave pattern all the time. Well, it was because quanta are both wave and particle. But this presents a deeper problem with our whole notion of time. We have a commonsense and historic expectation that time gives

identity, and different identities cannot both be one and the same time at the same place. Remember time can be very tricky in quantum physics. Additionally, we have seen that particles are local and superposition waves are non-local – more field-like with tentacles which can spread out infinitely by the way! Remember the previous quote by Dirac telling us, "*Any state may be considered as the result of a superposition of two or more other states, and indeed in an infinite number of ways.*" So, not only are quanta both wave and particle but they are also local and non-local. Try to wrap your head around that!

Additionally, everything about quanta has to do with randomness, uncertainty, and probability. This is the rule rather than the exception in quantum mechanics. Additionally, quantum mechanics has a spooky observer effect which is unconcerned with our conventional expectations. This will come up repeatedly in this book in different ways. How in the heck can single particles be localized as dots on a screen eventually accumulating as an interference pattern on a screen? Under different conditions, detection and non-detection, and at the same time and space be spread-out particles and wavelike? If physics were Newtonian, we would only need a particle's position and momentum to understand its state, its mechanics of motion. The position and momentum are like initial conditions which can predict the particle's full mechanical trajectory. Not so with a quantum particle. The state of a quantum particle is determined by the quantum wave function.

> For now, let's assume that the "system" consists of a single particle living in a one-dimensional universe…
>
> Then, if this were a classical particle, the "state" of the system would consist of just two numbers: its position x and its momentum px (or velocity vx, which you can easily calculate from the momentum). (You can think of these two numbers as the initial conditions that you would need in order to predict the particle's full trajectory using Newton's

second law.) For a quantum particle, the “state” instead consists of the wavefunction ψ(x), a whole infinity of numbers (one for each x). Quantum states are vastly more complicated, and interesting, than classical states…

Explaining how a particle can be localized under some conditions but spread-out and wavelike under other conditions is quite a challenge… [131]

As mentioned, electrons and photons are particles and waves made up of wavicles. So are elementary particles in the Standard Model of Elementary Particles which details all currently known elementary particles, The Standard Model of Elementary Particles makes up everything we currently know, see, understand, and what most of us erroneously think of as ‘commonsense’ about the universe. This will be discussed in more detail later.

One more oddity, if you look at the single-slit pattern below very closely you will see a pair of faint horizontal bands on each side of the bright center pattern. This is not a quantum wave interference pattern but a classical frequency pattern of the particle with frequency delays caused by the slit edge. The number of bands on each side depends on the width of the slit and the wavelength of the light. The intensity of the bands decreases as their distance from the central maximum increases.

Single-slit Diffraction Pattern of a Classical Particle

Laser light passing through a single slit, showing basic diffraction pattern.

For the double-slit interference pattern these interference patterns are a bit like standing waves in classical physics. In the double-slit experiment, light waves from two slits interfere with each other and create a pattern of alternating bright and dark bands on a screen behind the slits. This pattern is similar to the pattern created by classical standing waves, which are formed by the interference of waves that are reflected back on themselves. However, the double-slit interference pattern is not a classical standing wave, but rather an interference pattern that results from the superposition of two waves.

Double-slit Interference Diffraction Pattern of a Quantum Particle

PURE STATES AND MIXED STATES – HARMONY AND MUSIC

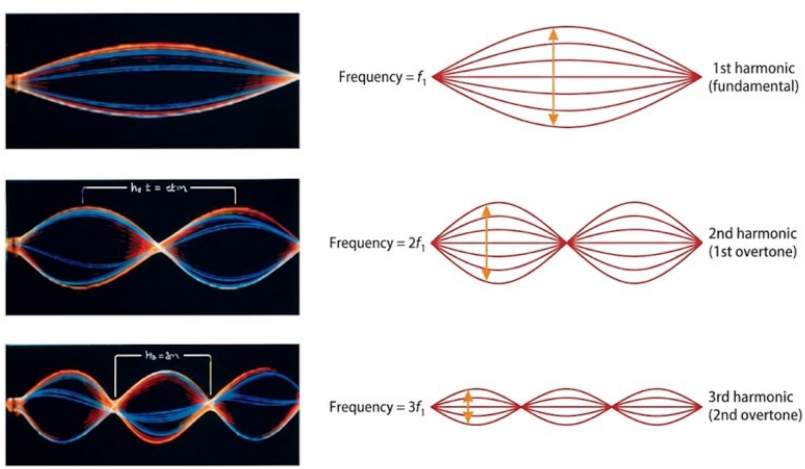
Harmony is Pure…

In quantum mechanics, a pure state is a state that can be described by a single quantum wave function. A pure state includes all the various energy permutations of a single quantum wave function. Pure states are idealized quantum states. Pure states are almost never actually observed in experiments, Pure states are quanta which *might* ideally be observed as a result of a single quantum wave function. This means an easy way to think about a pure state might be sort of like a guitar string sound after it is plucked at various intensities. Additionally, various harmonies of the fundamental frequency might have different amplitudes.

A coherent state is a special type of pure state that has a well-

defined phase and minimum uncertainty in position and momentum. Therefore, all coherent states are pure states, but not all pure states are coherent states. In quantum mechanics, a coherent state is a specific quantum state of the quantum harmonic oscillator that has dynamics most closely resembling the oscillatory behavior of a classical harmonic oscillator. It was first derived by Erwin Schrödinger in 1926 while searching for solutions of the Schrödinger equation that satisfy the correspondence principle. Harmonic oscillators have integer multiples of a fundamental frequency. Technically, coherent states are a special case of bosonic systems. Bosons are one class of fundamental particles which have an integer spin. The other class are fermions which have half-integer spins. Bosons love to mix with each other. Fermions are loners. An example of a boson is a photon. Because bosons have integer spin and harmonic oscillators are integer multiples of a fundamental frequency, they share an analogical relationship.

A classical standing wave is a wave that oscillates in time but whose peak amplitude profile does not move in space. It is also known as a stationary wave.



The peak amplitude of the wave oscillations at any point in space is constant with respect to time, and the oscillations at different points throughout the wave are in phase. The locations at which the absolute value of the amplitude is minimum are called nodes, and the locations where the absolute value of the amplitude is maximum are called antinodes. Standing waves can occur because the medium is moving in the direction opposite to the movement of the wave, or it can arise in a stationary medium as a result of interference between two waves traveling in opposite directions. If a standing wave could be heard musically it would not be cacophonic (harsh or discordant) but would sound harmonious. Any kind of wave can be thought of as harmonic if its frequency is an integral multiple of its fundamental frequency. Standing waves in classical physics can also be analogous to a type of ideal stationary quantum state which is independent of time called a pure state.

Music is Mixed Harmonies…

Any mixture of pure states is called a mixed state. Certain combinations of pure states can generate mixed states. Because of the Heisenberg uncertainty principle there is no state that is simultaneous for all observables. So, for example, we cannot know both the state of a position measurement and a momentum measurement at the same time. One of these states will have a range of possibilities. Additionally, due to the observer effect, performing a measurement on the state changes the state. Measuring an observable will put the system in an eigenstate changing the system unless the system has already been observed. Then as long as the measurement is directly consecutive in time the same results will be measured.

As a side note, here is an odd thing about incompatible observables like position and momentum – order matters.

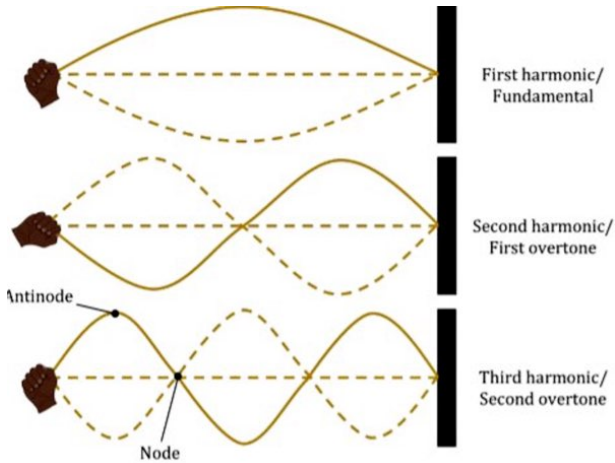
> Consider two incompatible observables, A and B, where A corresponds to a measurement earlier in time than B.

> Suppose that the system is in an eigenstate of B at the experiment's beginning. If we measure only B, all runs of the experiment will yield the same result. If we measure first A and then B in the same run of the experiment, the system will transfer to an eigenstate of A after the first measurement, and we will generally notice that the results of B are statistical. Thus: Quantum mechanical measurements influence one another, and the order in which they are performed is important. [135]

These pure states are called eigenstates. The diagram below shows pure states for the '***probability density***', a measure of how probable it is to find an electron around a hydrogen atom in a certain region. More simply, where an electron might be given certain energy levels around the nucleus of a hydrogen atom as shown in the diagram below. The brighter areas represent higher probability areas of finding an electron.

An orbital is not necessarily shaped like the way planets orbit the sun. It is better to think of orbitals as various geometric shaped regions around an atom's nucleus. According to the atomic theory and quantum mechanics, an atomic orbital is a function describing the location and wave-like behavior of an electron in an atom. The term atomic orbital may also refer to the physical region or space where the electron can be calculated to be present, as predicted by the particular mathematical form of the orbital. In Rutherford's atomic model, electrons revolve around the nucleus in circular paths called orbits. However, this model was later replaced by the quantum mechanical model which describes electrons as existing as what classical physics calls standing waves. Thus, electrons do not orbit a nucleus in the manner of a planet orbiting the Sun, but instead are more like classical standing waves. [136] A classical standing wave is a type of wave that is formed by adding two waves of the same frequency and amplitude traveling in opposite directions. The diagram below shows the first three harmonics of a

standing wave but just as quantum eigenstates correspond to atomic orbitals classical standing waves can have ‘harmonics’.



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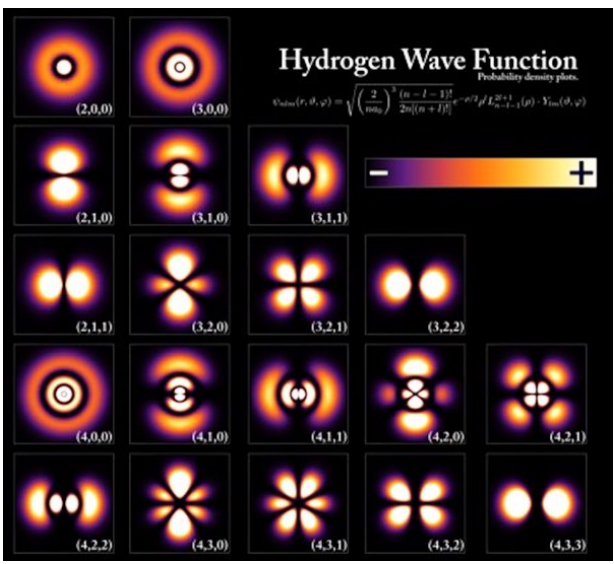
Unlike a traveling wave, a standing wave does not appear to travel. Each point on the standing wave will oscillate about a point on the axis of the wave. Adjacent points are in phase with each other (sections of the wave flap up and down together), so that points of a particular phase remain at a fixed location as time progresses. 138 Simple examples of standing waves are like jump ropes or guitar strings which are fixed at both ends. Thus, quantum eigenstates can be analogously thought of like classical standing waves but there are extreme differences between pure eigenstates in superposition and classical standing waves.

The diagram below shows different eigenstates of an electron in a hydrogen atom. The numbers and colors you see associated with each state are: (n, ℓ, m)

- the principal quantum number ‘n’ which reflects the energy level of the electron
- the angular momentum number ‘ℓ’ is an integer which

determines the shape of the electron's orbital.

- the magnetic quantum number 'm' is an integer that determines the orientation of the orbital in space.
- the spin z-component indicates half integers or integers divided by two indicated by colors where white represents a zero value and usually red/blue colors indicate diverging spin values.



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Probability densities for the electron of a hydrogen atom in different quantum states. 140

The orbital changes discretely, in jumps, as more energy is applied. The lowest energy level is shown at (2,0,0) and the highest energy level is shown at (4,3,3). Here is a movie which shows how these eigenstates change with increased energy.

The Helium Atom

The energy of an eigenstate for a particle can be analyzed in an

infinite, one-dimensional square potential ‘well’ to be discussed further down. Interesting enough the modes for displacement of a standing wave of a guitar string between two rigid posts have a similar form to the energy of eigenstates. Eigenstates are called pure states of a quantum particle in physics. This is much like musical tones. But first, we already know that quantum particles are not described by classical physics but by the quantum wave function of quantum physics.

Pure States and Quantum Collapse

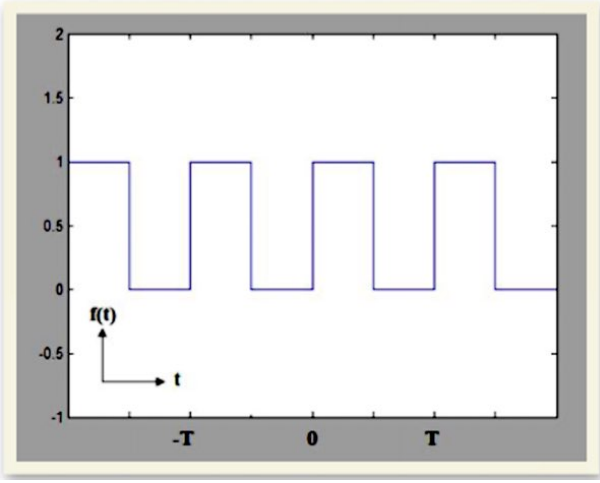
A pure state represents a quantum system in a definite and unambiguous configuration. Pure states are very rare in nature. However, when a system is sufficiently isolated from the environment, pure states can be achieved in a laboratory situation. Pure states are described by a single wave function. When a system is in a pure state, its properties (such as position, momentum, or spin) can be precisely determined. Mathematically, a pure state corresponds to a normalized vector in the Hilbert space, denoted by the symbol ψ. The wave function of a quantum system always evolves unitarily according to the system’s Hamiltonian (the operator representing its total energy). This evolution is continuous and deterministic, governed by the Schrödinger equation. No abrupt “collapse” occurs during this evolution. The concept of collapse can be misunderstood. The moment of measurement, which some mistakenly call “collapse,” merely signifies that an answer to a question (e.g., a measured value) becomes definite by the act of measurement. Before measurement, probabilities describe the system’s behavior. When an observer performs a measurement, the system’s wave function interacts with the measuring apparatus. This interaction is already incorporated, a-temporally, as part of the wave function all along. This also sets up the conditions for what is called the observer effect. If the initial state (before measurement) has been manipulated to be in an eigenstate, a pure state, of the

measured observable (e.g., position or energy), the measurement outcome is predetermined. The system then "collapses" into the corresponding eigenstate, and the measured value becomes certain. However, this collapse is not a physical discontinuity; it's a settling of probabilities into a specific outcome. The unmeasured outcomes are not forgotten; they remain encoded in the overall wave function, ready for further predictions. Measurement induces an irreversible change on the system's density matrix (an alternative representation of its state). This change is analogous to the collapse of the state vector (wave function collapse). Importantly, a proper mixture (a statistical ensemble of states) cannot be converted back into a pure state through measurement. Pure states exist both before and after measurement. The wave function's evolution remains unitary, and measurement outcomes settle probabilistic uncertainties. 141

Musical Quantum Waves

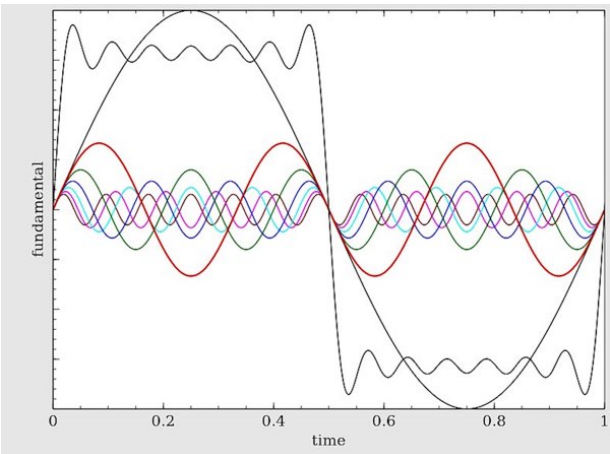
In the next section I will get into much more detail about the quantum wave function and how bizarrely different it is from any categories of understanding which classicism has provided us with. Throughout history the observer effect has 'collapsed' the quantum wave function condensing into commonsense judgements about the world. For example, a pure quantum state is a state in which a quantum system is in a definite state with respect to a particular observable meaning what happens when we collapse the double slit interference pattern on a screen to 'observe' it. However, we can draw what I call analogies from classical physics to give us clues about this nether-world of quantum superposition. Since the quantum wave function describes complex waveforms, the mathematics of Fourier transformations can simulate complex quantum waves by mathematically dissecting them down within limits to constituent simpler waves. Many waves in the 'real' world, whether it be water waves, electromagnetic waves, earthquake

shock waves are highly complex. However, the ingenious way in which the Fourier transformation works is that it mathematically deconstructs more complex waveforms by breaking them down into multiple, standard trigonometry frequencies of waves like sine and cosine. The component waves can be added or summed together to approximate the original complex waveform. Some complex wave forms might take an infinity of simpler component waves to exactly reconstruct the complex waveform. The original complex waveform might look like a perfect square waveform like the waveform below.



The square wave is a time domain complex waveform because if you simply observe it on a graph of time versus amplitude it will look like the waveform above. But the square wave is a very complex waveform which would probably take an infinity of simpler Fourier waveforms to replicate exactly in the frequency domain. The frequency domain simply observes the waveform on a graph of frequencies versus amplitudes like the picture below. The picture below shows a truncation of the infinity of simple sine

waves derived from the Fourier transformation. The squarer looking wave in the picture would be an approximate summation of all the constituent sine waves shown. The largest sine wave in the picture is called the fundamental frequency.



If we were to use the Fourier transformation to get, say a thousand more constituent sine waves, the resultant wave would look much more like a square wave. But in the case of a square wave, it would take an infinity of sine waves to exactly replicate the square wave. The square wave example is continuous meaning it simply repeats over and over the same way. If the wave function is a one-time spike called an impulse wave it is called discrete. Fourier mathematics accommodates all these combinations.

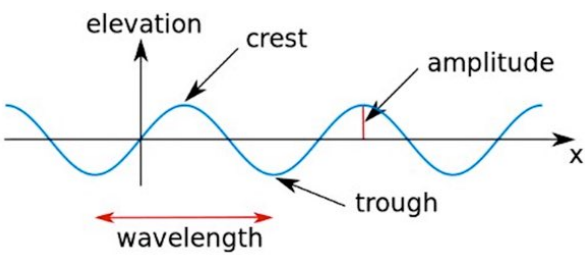
We know that the classical representation of the interference pattern on the double slit experiment looks like a complex wave. There are many important differences with the quantum waveforms in superposition but there are classical analog mathematical tools which can have startling similarities to narrow aspects of the quantum wave. It is important to note that there is no ‘same’ in the classical tools which have a utilitarian and analogical resemblance

to a quantum wave. The Fourier transformation is one example of this. But there is more.

The Fourier transform simply changes the way something is represented. For example, the idea ‘I love You’ can be said or represented in English or French. In our classical world, the Fourier transform can represent a complex signal as a time vs. amplitude varying signal or a frequency vs. amplitude signal. It is the same signal just mathematically represented differently. In the case of the idea ‘I Love You’ the Fourier transform allows us to translate between English and French in either direction. In the quantum world, the Fourier transform can represent a quantum wave function as momentum vs. space or a quantum wave function as position vs. space.

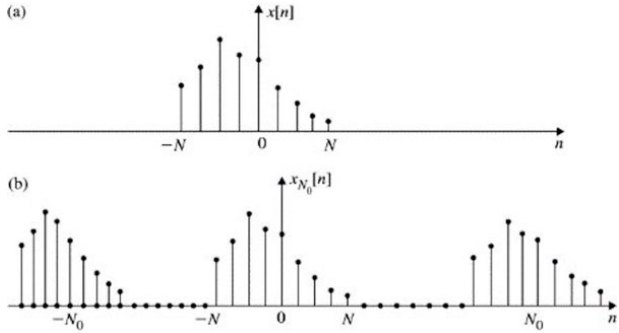
Classical World

In the classical world, the Fourier transform is a mathematical tool that allows us to represent periodic functions as a sum of simpler trigonometric functions. This Fourier transform has several different forms, including the continuous Fourier series and the discrete Fourier series. The continuous Fourier series is used to represent continuous-time periodic signals meaning the signal like a sine wave always looks the same no matter where you look at it in time.



while the discrete Fourier series is used to represent discrete-

time or impulse/spike-like periodic signals.



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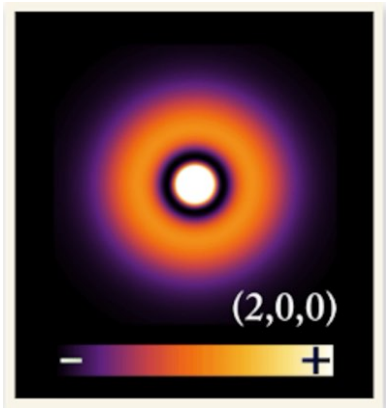
On the other hand, the quantum Fourier transform is a quantum algorithm that is used to perform the Fourier transform on mixed state quantum waves. In the quantum wave function world its analogue is the discrete Fourier transform. The quantum Fourier transform is a fundamental subroutine in many quantum algorithms, including Shor's algorithm for factoring large numbers. Any quantum wave function can be written as a linear combination of momentum eigenfunctions. Basically, the quantum Fourier transforms a complex wave function into constituent pure eigenstates which when added together will look like the quantum complex wave function. 146 There are two types of quantum Fourier transform: continuous quantum Fourier transform and discrete quantum Fourier transform. The discrete quantum Fourier transform is a discrete version of the continuous quantum Fourier transform. One important difference between the classical world and the quantum world is that in the quantum world a wave function as a linear combination of momentum eigenfunctions, but there are also weights for each of the constituent eigenfunctions which indicate how much a particular eigenfunction contributes to the overall complex or mixed quantum wave. 147

In musical notes we are ‘hearing’ a complex waveform. We can take any time segment of a musical note and perform a Fourier transformation on it to find its constituent frequencies. If our musical note has integer multiples of these constituent simpler sine waves, we think of that as ‘harmonic’. It is pleasing to hear at least from a classical music point of view. This is the analogous equivalent of our pure quantum states at different energies. If we play a musical note louder or softer depending on the musical instrument the mix of all the constituent harmonic frequencies’ amplitudes can change in what we think of as the timbre changing, the quality of the sound, but the fundamental frequency will not change. This is because we are adding more or less energy to the complex waveform. If our ‘pleasant sounding’ waveforms are not results of integer frequencies like perhaps fractional frequencies, we are accustomed in the West to think they sound cacophonous or harsh and discordant.

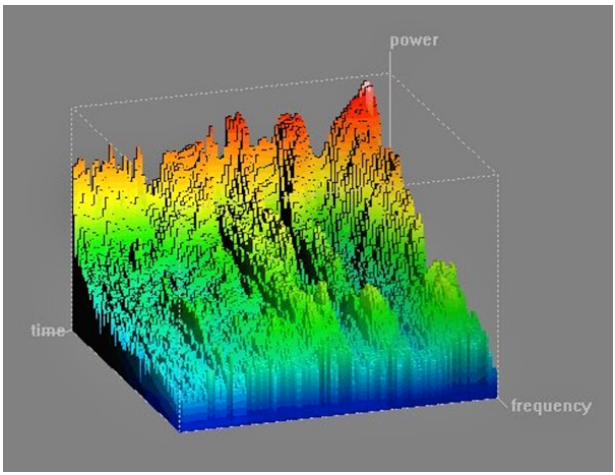
The diagram below is a time lapse of probability densities for finding the electron of a hydrogen atom in different quantum energy states. Remember these energy states are quantized. This means they jump from one energy level to the next energy level. As energy is increased from a low energy state (2,0,0) to a high energy state (4,3,3) the probability for finding an electron in an atomic shell of a hydrogen atom changes. Note that the orbitals need not be circular or spherical. These are pure, eigenstates. This means it is the quantized digital solutions for finding an electron around a hydrogen atom when various energies are applied to the atom.



Pure Eigenstates

Note: If the animation does not work click on the link in the footnote.

The diagram below shows a spectrum of frequencies for a classical analog sound (think of a note) in terms of time, frequency, and power (amplitude). If we were to take the peak frequencies at each moment in time, the tops of the power axis would be analogous to patterns of the solutions of the quantum wave function as shown above.



Classical Analogue Note

The eigenstate probability densities for finding an electron around the nucleus of a hydrogen atom would look analogously similar to the analogue note diagram above. But the domain of quantum superposition is quite different from the classical analogue world of musical sounds. The point is that from classical science and mathematics we can find tools which have analogous utility in the wildly different nonclassical quantum wave function.

The pure quantum states just discussed correspond to a mathematical object called a quantum oscillator. Metaphorically the quantum oscillator has a resemblance to something called a classical harmonic oscillator. A classical oscillator simply generates a continuous waveform. For older folks we remember the synthesizer. The synthesizer was a cornucopia of what you can do with classical harmonic oscillators. A pure quantum state is a state that can be described by a single wave function not multiple quantum wave functions added together in superposition. In the context of the quantum harmonic oscillator, a pure quantum state is an energy eigenstate of Hamiltonian mathematics. The energy eigenstates of the quantum harmonic oscillator are mathematically Hermite functions. Hermite functions are complex, and I will only state that they are fixed sequences of polynomials because they make my brain hurt too much. [150] The Hermite functions are a set of eigenfunctions of the continuous Fourier transform. We might be able to think of the Hermite polynomials as individual ‘notes’ in the quantum wave function. One difference though is that these ‘notes’ are infinite. The point is that pure quantum states have an analogous similarity to our old-time synthesizer music (you can also hear these sounds on old episodes of Star Trek). When we start mixing one harmonic oscillator with another harmonic oscillator, we can think of this sort of like mixed quantum states. A mixed quantum state is a probabilistic mixture of pure states. In the

context of the quantum harmonic oscillator, a mixed quantum state is a linear combination of energy eigenstates.

Believe it or not there is even a quantum music project which combines quantum physics and music to produce a traveling quantum production. I am not sure it will find its way to the top 40, top 100, or top 2^n.

> The main outcome of the pilot project was an interactive multimedia show Quantum Music, featuring new, specially designed hybrid keyboard instruments, new library of quantum sounds developed from the experiments and formulas of quantum physics and new compositions written specially for this show.[151]

The mathematical equations that describe the quantum harmonic oscillator in the quantum domain of superposition and the classical physics of musical notes have an analogous relationship. Both systems exhibit wave-like behavior, and the energy levels of the quantum harmonic oscillator are a classical simile to the different harmonics of a musical note.

However, it's important to note that the analogy between the quantum harmonic oscillator and musical notes is not perfect, and there are some important differences between the two systems. For example, the quantum harmonic oscillator stems from a purely mathematical construct which has a highly problematic relationship with 'experience', while musical notes are classically physical phenomena that can be heard and experienced. Additionally, the quantum harmonic oscillator has an infinite number of discrete energy levels that actually vanish at infinity. Contrarily, musical notes have a finite number of harmonics in terms of the practicality of sound. Nonetheless, the analogy between the two systems is a useful way to understand the quantum harmonic oscillator and its properties.

The quantum harmonic oscillator is a fundamental model system

in quantum mechanics that is analogous to the classical harmonic oscillator. The energy levels of a quantum harmonic oscillator are quantized, meaning that they can only take on certain discrete values. The energy level in the quantum harmonic oscillator jumps from one energy level to another like the orbitals of an electron around an atom. The translation of the classical Fourier transforms as 'frequencies' of the complex quantum wavefunction ignores some other important differences. The entire wave function as a single 'universal wave function' (to be discussed in the next section) has a simultaneity which is oblivious to spacetime. In contrast, the frequencies of musical notes are classically analogous meaning that they change continuously over the entire audible frequency spectrum as the above diagram displays. Interesting enough, the observer effect to be discussed in more detail in the next section conditions what is 'actually' perceived or measured. Music appreciation also seems to depend heavily on the ears of the observer. What is most interesting is that the quantum harmonic oscillator is based on the only function which has an exact wave function solution.

A Deeper Dive - Quantum Energy Potential Deep Well

The quantum wave function is a mathematical description of the state of a quantum system. It is used to calculate the probability of finding a particle in a particular position or momentum. The potential energy in the quantum wave function is represented by the quantum potential, which is a term within the Schrödinger equation that guides the movement of quantum particles. Think of potential energy as a kind of stored energy which can be converted into kinetic energy. For example, if I am standing on top of a snow laden mountain with a pair of skis, there is a stored potential energy which is not actual kinetic energy until I start moving down the slope. The quantum potential is also referred to as quantum potential energy, Bohm potential, quantum Bohm potential, or

Bohm quantum potential. The quantum potential is not infinite in the quantum wave function. It is a function of the amplitude of the wave function and depends on the curvature of the amplitude of the wave function. However, quantum wave equations can be made simpler if negligible possibilities are truncated from the start. This applies to potential energies but can also apply to probability densities, quantum interference, entropy, and certain types of perturbation or mathematically understood specific dynamic changes in the wave function. A potential well is a mathematical technique used to simplify computations.

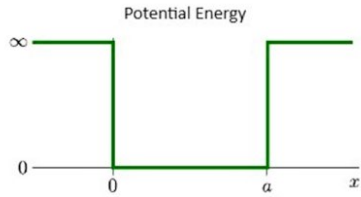
A potential well is a purely mathematical region surrounding a local minimum of potential energy. Energy captured in a potential well is unable to convert to another type of energy because it is captured in the local minimum of a potential well. Therefore, a body may not proceed to the global minimum of potential energy called zero point or vacuum energy, as it would naturally tend to do due to entropy. In quantum physics, potential energy may escape a potential well without added energy due to the probabilistic characteristics of quantum particles. In these cases, a particle may be imagined to tunnel through the walls of a potential well. [152] In quantum physics probability has no association with cause. Events can happen which have nothing to do with 'reason' or some underlying factors we have no knowledge of. That fallback idea nourished in classical thought has been proven to simply be false in quantum superposition. Think of the potential well as a graph of a 2D potential energy function. It is like the potential energy surface that can be imagined as the Earth's surface in a landscape of hills and valleys. Then a potential well would be a valley surrounded on all sides by higher terrain. This valley could be filled with water (e.g., be a lake) without any water flowing away toward another, lower minimum. [153] Quantum confinement is responsible for the increase of energy difference between energy states and band gap, a phenomenon tightly related to the optical and electronic properties of the materials. The equivalent of this valley in the quantum world

can be accomplished as quantum confinement. For example, quantum confinement can occur once the diameter of a material is of the same magnitude as the de Broglie wavelength of the electron wave function.

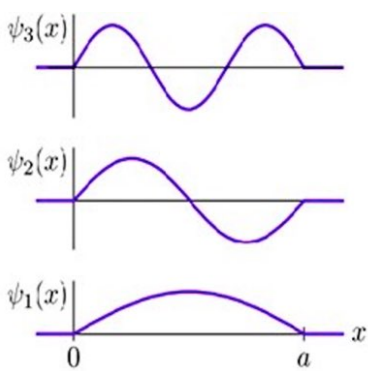
One note to illustrate how quantum spookiness can bleed into our macroscopic classical world. Quantum tunneling is a quantum mechanical phenomenon in which an object such as an electron or atom passes through a potential energy barrier that, according to classical mechanics, the object does not have sufficient energy to enter or surmount. But this is not a consequence of the quantum wave function since it is vastly different from classical notions as for example non-spacetime, uncaused, and without origin to name a few. Non-spacetime, uncaused, and without origin are thought in a reductive totality of the 'not'. In this way the 'not' accounts for an excess to this binary duality. But the quantum wave function exceeds these classical determinations. The quantum wave function describes the state of a particle or other system, and wave equations such as the Schrödinger equation describe their behavior. Tunneling plays an essential role in physical phenomena such as nuclear fusion and alpha radioactive decay of atomic nuclei. But even the most common phenomenon in our macroscopic classical world has direct links to this very strange phenomenon. The transistor was invented in 1947. While quantum technology was around then it is highly likely that the inventor of the transistor knew nothing about this phenomenon – it just worked based on quantum tunneling. The technological era would likely not have happened without the invention of the transistor and the very weird phenomenon of quantum tunneling. 154

A Deeper Dive – The Infinite Square Well

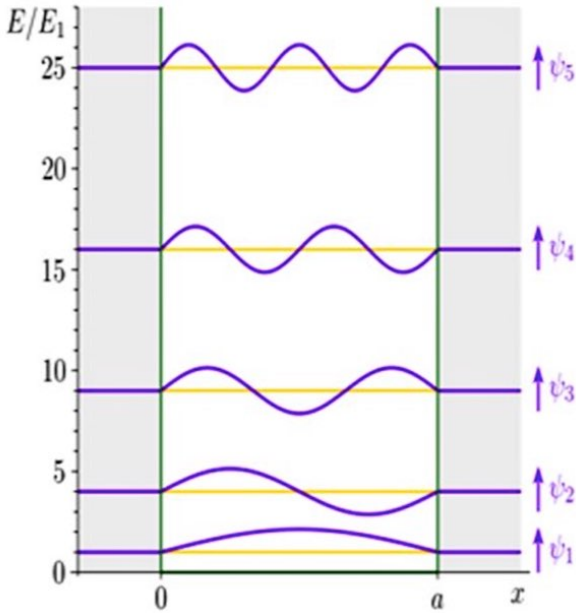
An exaggeration of the quantum energy potential deep well is an ideal system with zero potential energy inside the 'well' and infinite potential energy outside the 'well'. We can think about it like this,



The box size in this ideal case is exactly the wavelength of the particle/wave in the box. Because there is no potential energy outside our well, there is no probability of finding a particle outside the well. This means the wave function is zero in these regions. It also means that no potential energy inside the well means all the energy is kinetic. This implies the energy is definite and fixed and so is the momentum, but momentum can be positive or negative. It also means that the wavelengths inside the well are integer multiples of the fundamental wavelength or harmonics. This implies that the wavefunction is in this ideal situation definite. It will result in fixed values. The result of all this is that we have standing waves like harmonics at each value of 'x' between zero and 'a' like the diagram below.



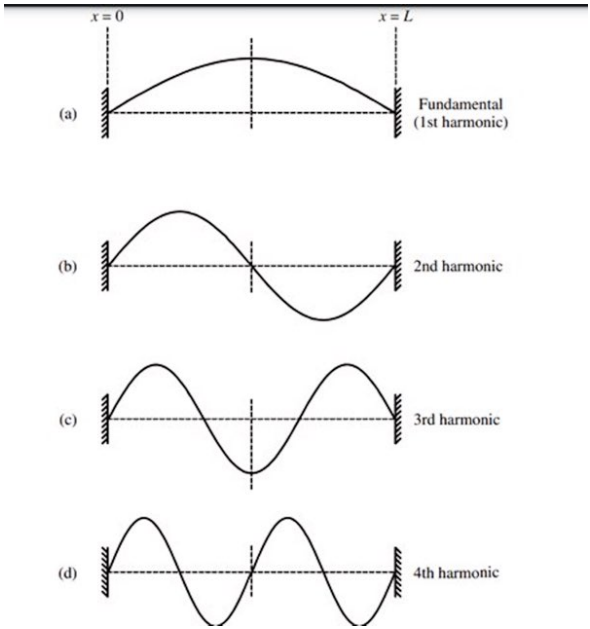
Or like this,



These are ‘quantum harmonics’ and they are the definition of eigenstates, pure states. 157

The Muse of Waves

The classical analogue of this is musical harmonics as shown below,



In musical notes we saw that there is the fundamental 1st harmonic tone and the other harmonics of the fundamental frequency which are integer multiples of the fundamental like 2nd, 3rd, 4th, … We also saw that quantum energy eigenstates or pure states have similarities to classical standing waves which can be decomposed into classical states using the quantum Fourier transform in which there is the fundamental 1st 'harmonic tone' integer which discretely transforms as more energy is applied to multiples of the fundamental like 2nd, 3rd, 4th, … These constituent harmonics in the quantum domain of one eigenstate can be thought of as notes, frequencies, harmonics, which have less and less energy as their discrete quantum Fourier series approach infinity. In physics and music most of the time, tones are not pure they are mixed which means complex frequencies are not given in terms of multiples of one fundamental frequency. In physics these are called mixed states. As the detectors indicate, when

phenomenon is being observed the symphony of existence begins. When phenomenon is not being measured, observed, it is in a superposition state where the cacophony of existence reverts to abyssal chaos without origin. [159] Pardon my indulgence here but I want to take a couple excerpts from my previous posts...

> Standing waves are a moment when waves combine perfectly to create their highest moment or amplitude. Instead of fighting each other the waves unite as a collectivity, a whole moment of their highest goal, culmination or perhaps, telos in Greek thought. This is the discrete octaves of quantum mechanics. The nuclei pull in chaotic radiation and photons to create an electron and an excess amount of energy which is called kinetic or in Aristotle's terms 'actual' energy...
>
> Linearity is the standing wave of our existence. It is the moment when the universe gathers itself, rouses itself, from the slumber of chaos and declares, "I am that I am" or tat tvam asi (Buddhism: thou art that; the union of Atman (individual, self, soul) and Brahman (universal consciousness, Absolute) as plurality/one, wave/particle uncertainty(?)…). Whatever we call reality, it is not an unchanging permanence otherwise it would be mechanical, the dead metaphysics of mechanism. The beauty of existence is the standing moment of harmony and unity which does not have to be, given the wave nature of reality arising out of pure energy, chaotic energy and yet, nevertheless, is. [160]

> Space and time are not static but widely stratified on many different levels. It is more like a silent symphony where there are many parts all playing simultaneously from which we draw a 'whole of meaning', as sense of uniformity in the movement of widely varying harmonies and melodies. The meaning we draw from the symphony makes it something other than pure random noise. We find ourselves drawn to

the flow of its movements. Movements in a symphony have a stretch of quality not just tempo. It is wide ranging from ecstatic to depressing. We draw meaning from this incalculable variety. In the same way, time and space are the movement of meaning for living humans. We draw from its deep wells. These wells are called history and language. 161

Complementarity

It seems to me that Einstein understood the wavicle problem as a necessary contradiction of quantum phenomena. He simply tells us that *he feels compelled to ascribe objective reality to both*. Some might have thought perhaps this lent a sense of incompleteness to quantum physics. But it turns out that they were wrong, and Einstein was right. But logic, the principle of noncontradiction, tells us that light cannot be both particle and wave. In Book 4, Part 3 of Aristotle's Metaphysics, he tells us,

The Most Fundamental Principle of Knowledge: The Law of Non-Contradiction

Which principle this is, let us proceed to say. It is this: the same attribute cannot at the same time belong and not belong to the same subject and in the same respect--we must presuppose, to guard against dialectical objections, any further qualifications which might be added.

This, then, is the most certain of all principles, since it answers to the definition given above. For it is impossible for any one to believe the same thing to be and not to be, as some think Heraclitus says. For what a man says, he does not necessarily believe; and if (1) it is impossible that contrary attributes should belong at the same time to the same subject (the usual qualifications must be presupposed in this premise too), and if (2) an opinion which contradicts another is contrary to it, then obviously (3) it is impossible for the same

> man at the same time to believe the same thing to be and not to be; for if a man were mistaken on this point he would have contrary opinions at the same time.... 162

To think of light as both wave and particle is as contradictory as it gets. However, this is not a statement about the 'truth' of science but about our idea of reality inherited from Aristotle, the principle of noncontradiction. It was very hard for physicists to peel themselves away from the force of classical physics. However, these contradictions or dualities kept coming up repeatedly as we will find out and eventually 20th century physics had to give up the ghost of classicism. However, ingeniously, they did eventually find a way to make classical physics a limited case of the new burgeoning physics given quite a number of assumptions such as absolute time and space to start with.

Regarding both wave and particle, in effect, Bohr said, 'suck it up' and let's call it complementarity. Bohr was willing to let the observed phenomena show itself without making judgements based on preconceptions or certain institutionally conservative incentives to frame these observations in more classical terms. Complementarity was more like 'both-and' as opposed to 'either-or' with the important caveat that 'both-and' does not resolve to a higher order which unifies them. In this case, both-and amounts to a bold-faced contradiction which logic cannot ever resolve, even in principle due to Bell's theorem and much work afterward. However, regarding the complementarity principle Professor Emeritus of Physics at New York University and Professor of Mathematics at University College London, Alan Sokal tells us,

> A second important aspect of quantum mechanics is its principle of complementarity or dialecticism. Is light a particle or a wave? Complementarity ``is the realization that particle and wave behavior are mutually exclusive, yet that both are necessary for a complete description of all

> phenomena [Heisenberg]." More generally, notes Heisenberg, the different intuitive pictures which we use to describe atomic systems, although fully adequate for given experiments, are nevertheless mutually exclusive. Thus, for instance, the Bohr atom can be described as a small-scale planetary system, having a central atomic nucleus about which the external electrons revolve. For other experiments, however, it might be more convenient to imagine that the atomic nucleus is surrounded by a system of stationary waves whose frequency is characteristic of the radiation emanating from the atom. Finally, we can consider the atom chemically. ...Each picture is legitimate when used in the right place, but the different pictures are contradictory and therefore we call them mutually complementary [Heisenberg]. 163

To some degree, Bohr glossed over the obvious contradictory problem of wavicles into his nicer sounding complementarity principle while still maintaining that the contradiction could never be resolved. Heisenberg also retains that both wave and particle "*are nevertheless mutually exclusive*" and that "*the different pictures are contradictory and therefore we call them mutually complementary*."

However, Sokal adds a more Hegelian idea to complementarity as 'dialectical' when he tells us, "*A second important aspect of quantum mechanics is its principle of complementarity or dialecticism.*" Sokal appears to understand Bohr's contradiction as resolved or transformed dialectically to a higher order as complementarity. In this case the contradiction in its refusal of each other as wave and particle would give way to a higher order, a transformation, which would maintain both contradictory elements. If we deconstruct what Sokal tells us, it appears that dialectic resolves contradiction in the notion of complementarity. It seems to me that this is a bit of an obfuscation which cloaks the idea that what is really getting lifted up is a hidden supposition to the text of Heisenberg wherein contradiction is resolved by complementarity. In other words,

contradiction can remain as long as the contradiction is lifted up into a mutual reciprocity which complements each other. However, what gets lost in this notion is the spookiness which lies behind the contradiction. The contradiction is not a mere contradiction but the tip of a 'reality' devastating wrecking ball due to the observer effect's impact on any such notion as a classical, orderly 'reality' of *phusis*. This is not your mother's idea of a contradiction. This is something very different which changes everything.

The subtlety of complementarity as dialectic attempts to get around the nastier problem of outright contradiction in a peculiar way which serves as a good example of a notion in postmodernism. The postmodernist Jacques Derrida (1930-2004) would probably see the apparent resolve of the contradiction into a dialectical moment as a sub-text in the margin which cannot be made explicit but simultaneously guides and deconstructs itself totally from within its text, itself. More generally, Derrida calls this the history of *logocentrism*. I point this out not to be too critical of Sokal but as an example of the decades of concerted attempts in the 20th century to integrate the findings of quantum physics into a classical schema and therefore lay hold of classicism once again.

To add insult to injury Bohr said, "*An independent reality in the ordinary physical sense can ... neither be ascribed to the phenomena nor to the agencies of observation.*" [164] It turns out that complementarity is solely due to the way we look at it. The way we look at it determines what we see, i.e., wave or particle. This brings us back to the observer effect already mentioned. Sokal quoting Heisenberg tells us,

> We can no longer speak of the behaviour of the particle independently of the process of observation. As a final consequence, the natural laws formulated mathematically in quantum theory no longer deal with the elementary particles themselves but with our knowledge of them. Nor is it any longer possible to ask whether or not these particles exist in

space and time objectively ...

> When we speak of the picture of nature in the exact science of our age, we do not mean a picture of nature so much as a picture of our relationships with nature. ...Science no longer confronts nature as an objective observer, but sees itself as an actor in this interplay between man [sic] and nature. The scientific method of analysing, explaining and classifying has become conscious of its limitations, which arise out of the fact that by its intervention science alters and refashions the object of investigation. In other words, method and object can no longer be separated.[165]

Bohr and Heisenberg are not suggesting some sort of spooky, psychic observation. These are statements that have empirically verifiable results which depend on how we determine ahead of time what we want to see. The subject conducting the experiment is implicated by determining how we set up the double-slit experiment to see what we want to see. The reality, the object will then show us exactly what we want to see. So, not only do we have an unreconcilable contradiction but now we have confounded that notion with how the observer determines the outcome of the contradiction by what the observer is looking for. To say the least, this reflects disturbing inconsistencies in what we think of as 'reality' which we inherited from classicism and its offspring, modernism. Sokal introduces postmodernism below when he tells us,

And once again Bohr:

> A complete elucidation of one and the same object may require diverse points of view which defy a unique description. Indeed, strictly speaking, the conscious analysis of any concept stands in a relation of exclusion to its immediate application [Bohr].

This foreshadowing of postmodernist epistemology is by

> no means coincidental. The profound connections between complementarity and deconstruction have recently been elucidated by Froulagif and Honnergif, and, in great depth, by Plotnitsky. 166

Here is a more complete quote from Bohr which addresses Sokal's quote,

> For describing our mental activity, we require, on one hand, an objectively given content to be placed in opposition to a perceiving subject, while, on the other hand, as is already implied in such an assertion, no sharp separation between object and subject can be maintained, since the perceiving subject also belongs to our mental content. From these circumstances follows not only the relative meaning of every concept, or rather of every word, the meaning depending upon our arbitrary choice of view point, but also that we must, in general, be prepared to accept the fact that a complete elucidation of one and the same object may require diverse points of view which defy a unique description. Indeed, strictly speaking, the conscious analysis of any concept stands in a relation of exclusion to its immediate application. The necessity of taking recourse to a complementary, or reciprocal, mode of description is perhaps most familiar to us from psychological problems. 167

I find it interesting that Bohr associated the bizarre findings of quantum physics with psychology especially in light of 21st century neuroscience findings. But first, to get there I want to return briefly to Sokal's "postmodernist epistemology" comment.

In my opinion, the path of postmodernism has been sketchy because it has a tendency for some to fall back into more habitual ways of thinking. I think Sokal's comments on '*dialecticism*' illustrate this. It can be easy to take deconstruction into a more traditional

skepticism of conceptual thinking altogether. If conceptual thinking is a practice of beliefs which undo themselves within their own narrative, without any critique which can arise from an exterior to that narrative, then nothing can be asserted which is other than merely subjective, my belief. The interesting issue which postmodernism was acutely aware of is that even the belief that nothing can be asserted which does not undo itself from within. No thesis including 'merely subjective' or 'belief' can escape itself and thus, its own undoing.

Due to the observer effect, why should we not think of logocentrism as a repetition of itself, as yet another logocentrism, another endless spooky branching effect, many-worlds, of each observation? Traditionally, this is called a negative or infinite regression. From my engineering background I prefer to think about it as a positive feedback system. Undamped positive feedback will destroy any typical system. You have heard positive feedback when microphones are placed too close to a speaker. If the feedback is not squelched by an electronic mechanism, the feedback will cause too much current in the electronics and something in the circuit will fry. Perhaps obsession or insomnia is a kind of undamped biological positive feedback system which eventually causes biological harm. In the context of this book, the quantum wave function is a kind of positive feedback system which cannot exclude the observer. Yet, in quantum mechanics nature seems to have figured out a way to prevent the damaging effects of positive feedback by its incessant updating information prior to an ontic (particular) act of observation. As we will see, information as entangled information is not disorder, the opposite of order, but noisy and chaotic in a spooky way which resolves into classicism, classical finitude upon observation. Interestingly enough this has a lot in common with the functioning of our brain. Our brain is an 'information channel' that is very noisy. Yet, this 'noise' itself carries information which can be resolved (classically) as a thought. Claude Shannon's (1916-2001) paper named "A Mathematical Theory of Communication". The

paper mathematically tells us that every communication channel has a degree of noise. This noise can be characterized mathematically to tell us the maximum amount of useful information which can be transmitted in this channel. This is an astounding theory which in other terms tells us the background information of entropy in the system has a reciprocal relationship to what we can learn about the system.

The positive feedback system, the narrative of the text which undoes itself in deconstruction, is not utter desolation but noise which has a reciprocity to useful, dare I think pragmatic, information. In classical theory noise can be our enemy. In classicism clarity, noncontradiction, absolute time and space – the absolute is conceived as noise free. Classicism in this regard is a clean sterile environment…but life is messy and so is the chaos of the quantum wave function when it is not shielded from the environment to some degree in our experimental observations of it. The fully environmental quantum wave function surpasses complexity into the dark abyss of chaos which stares back at us in the observer effect. This will be clearer in the section, "The Quantum Wave Function".

There are many examples of complementarity in quantum physics. In his book "The Cosmic Landscape" Susskind gives us other interesting examples of the Complementarity Principle.

> With the possible exception of Einstein, Niels Bohr was the most philosophical of the fathers of modern physics. To Bohr the philosophical revolution that accompanied the discovery of quantum mechanics was all about complementarity. The complementarity of quantum mechanics was manifest in many ways, but Bohr's favorite example was the particle-wave duality that had been forced on physics by Einstein's photon. Is light a particle? Or is it a wave? The two are so different that they seem totally irreconcilable.
>
> Nevertheless, light is both a wave and a particle. Or more

accurately, for certain kinds of experiments light behaves like particles. A very dilute beam of light falling on a photographic plate leaves tiny black dots: discrete evidence of the indivisible particle nature of the photon. On the other hand, those dots will eventually add up to a wavy interference pattern, a phenomenon that makes sense only for waves. It all depends on how you observe the light and what experiment you do. The two descriptions are complementary, not contradictory.

Another example of complementarity has to do with Heisenberg's Uncertainty Principle. In classical physics the state of motion of a particle involves both its position and its momentum. But in quantum mechanics you either describe a particle by its position or its momentum—never both. The sentence, "A particle has a position AND a momentum," must be replaced by, "A particle has a position OR a momentum." Likewise, light is particles, OR light is waves. Whether you use one description or the other depends on the experiment.

Blackhole complementarity is the new kind of complementarity that results from combining quantum mechanics with the theory of gravity. There is no single answer to the question, "Who is right? The observer who remains outside the blackhole and sees all information radiated from just above the horizon? Or the observer who falls through with the bits that are heading toward the center of the blackhole?" Each is right in its own context: they are complementary descriptions of two different experiments. In the first the experimenter stays outside the blackhole. He may throw things in, collect photons as they come out, lower probes down to just above the horizon, observe the effects on the trajectories of particles passing near the blackhole, and so on.

But in the second kind of experiment, the physicist prepares an experiment in her lab. Then, lab and all, she

jumps into the blackhole, crossing the horizon, while performing the experiment.

The complementary descriptions of the two experiments are so radically different that it hardly seems credible that they could both be right. The external observer sees matter fall toward the horizon, slow down, and hover just above it.3 The temperature just above the horizon is intense and reduces all matter to particles, which are finally radiated back out. In fact the external observer, monitoring the in-falling observer, sees her vaporized and reemitted as Hawking radiation.

But this is nothing like what the freely falling observer experiences. Instead she passes safely through the horizon without even noticing it. No bump or jolt, no high temperature, no warning of any kind signals the fact that she has passed the point of no return. If the blackhole is big enough, let's say, with a few million light-year radius, she would sail on for another million years with no discomfort. No discomfort, that is, until she reaches the heart of the blackhole, where tidal forces—the distorting forces of gravity —eventually become so strong that . . . never mind, it's too gruesome.

Two such different descriptions sound contradictory. But what we have learned from Bohr, Heisenberg, and others after them is that apparent paradoxes of this type signal genuine contradictions only when they lead to conflicting expectations for a single experiment. There is no danger of incompatible experimental results because the freely falling observer can never communicate her safe passage to the outside. Once she has safely passed the horizon, she is permanently out of contact with all observers who remain outside the blackhole. Complementarity is strange but true.

The other major revolution of the early twentieth century was Einstein's Theory of Relativity. Certain things are

relative to the state of motion of the observer. Two different observers moving rapidly past each other will disagree about whether two events occurred at the same time. One observer might see two flashbulbs flash at exactly the same time. The other would see one flash take place before the other.

The Principle of Blackhole Complementarity is also a new and stronger relativity principle. Once again the description of events depends on the state of motion of the observer. Remaining at rest outside the blackhole, you see one thing. Falling freely toward the interior of the blackhole, you see the same events entirely differently.

Complementarity and relativity—the products of the great minds of the early twentieth century—are now being united in a radically new vision of space, time, and information. 168

We do not have to resolve the particle and wave (wavicle) duality which turns out to be essentially impossible.

Albert Einstein famously said that quantum mechanics should allow two objects to affect each other's behaviour instantly across vast distances, something he dubbed "spooky action at a distance". Decades after his death, experiments confirmed this. But, to this day, it remains unclear exactly how much coordination nature allows between distant objects. Now, five researchers say they have solved a theoretical problem that shows that the answer is, in principle, unknowable.

At the heart of the paper is a proof of a theorem in complexity theory, which is concerned with efficiency of algorithms. Earlier studies had shown this problem to be mathematically equivalent to the question of spooky action at a distance — also known as quantum entanglement.

The theorem concerns a game-theory problem, with a

team of two players who are able to coordinate their actions through quantum entanglement, even though they are not allowed to talk to each other. This enables both players to 'win' much more often than they would without quantum entanglement. But it is intrinsically impossible for the two players to calculate an optimal strategy, the authors show. This implies that it is impossible to calculate how much coordination they could theoretically achieve. "There is no algorithm that is going to tell you what is the maximal violation you can get in quantum mechanics," says co-author Thomas Vidick at the California Institute of Technology in Pasadena.

On the pure-math side, the problem was known as the Connes embedding problem, after the French mathematician and Fields medalist Alain Connes. It is a question in the theory of operators, a branch of math that itself arose from efforts to provide the foundations of quantum mechanics in the 1930s. Operators are matrices of numbers that can have either a finite or an infinite number of rows and columns. They have a crucial role in quantum theory, whereby each operator encodes an observable property of a physical object.

In a 1976 paper, using the language of operators, Connes asked whether quantum systems with infinitely many measurable variables could be approximated by simpler systems that have a finite number.

But the paper by Vidick and his collaborators showed that the answer is no: there are, in principle, quantum systems that cannot be approximated by 'finite' ones. According to work by physicist Boris Tsirelson, who reformulated the problem, this also means that it is impossible to calculate the amount of correlation that two such systems can display across space when entangled.

Disparate fields

The proof has come as a surprise to much of the

community. “I was sure that Tsirelson’s problem had a positive answer,” wrote Araújo in his comments, adding that the result shook his basic conviction that “nature is in some vague sense fundamentally finite.”

But researchers have barely begun to grasp the implications of the results. Quantum entanglement is at the heart of the nascent fields of quantum computing and quantum communications, and could be used as the basis of super-secure networks. In particular, measuring the amount of correlation between entangled objects in a communication system can provide proof that it is safe from eavesdropping. But the results probably do not have technological implications, Wehner says, because all applications use quantum systems that are ‘finite’. In fact, it could be difficult to even conceive an experiment that could test quantum weirdness on an intrinsically ‘infinite’ system, she says.

The confluence of complexity theory, quantum information and mathematics means that there are very few researchers who say that they are able to grasp all the facets of this paper. Connes himself told Nature that he was not qualified to comment. But he added that he was surprised by how many ramifications it has turned out to have. “It is amazing that the problem went so deep and I never foresaw that!”[169]

It is interesting to note here that already in the earlier part of the 20th century physicists were fully aware of how language and history had the tendency to impute a kind of universal understanding of phenomena. Concurrent with the twentieth century’s rise into quantum mechanics the eruption of philosophical phenomenology’s motto was ‘back to the thing’s themselves’. [170] ‘Back to the thing’s themselves’ did not mean ‘things’ as modernistic mechanism. Instead, it means how we encounter phenomenon without falling into the reductionary, binary duality’s narrative

which relegates, without excess, everything not ‘objective’ to ‘purely subjective’.

To return to the matter at hand, below is a thought analogy, given certain additional caveats, that some have reasoned why, for example, position and momentum of a photon cannot be measured at the same time. This analogy cannot be taken as universally true but certainly can impact experimental results in some cases. I call this analogy the ‘hammer’ analogy.

Suppose we wanted to measure the position and momentum of the moon. Now suppose we measured it by sending a mega planet to collide with it to let us see its position. When the mega planet hit the moon, we could see the moon’s position, but the moon would be sent off like a billiard ball into another direction with a much higher momentum than it had from the collision. This would make it impossible to measure the momentum of the moon. On the other hand, let’s say we wanted to measure the momentum of the moon while it travels around the earth. Momentum can be thought of as how hard something hits a surface. Let’s say we have a giant pressure gauge that will measure how hard something hits it. Let’s say the pressure gauge is bigger than the moon. So, while the moon is traveling around the earth, a giant hand comes down and inserts the pressure gauge directly in the path of the oncoming moon. When the moon hits the gauge, we immediately read how hard the impact was. Now, we know the momentum the moon had but the path it was taken has been wiped out by hitting the pressure gauge. That being stated for some cases, quantum physics has devised very specific, least intrusive ways for validating the complementarity of waves and particles. This is why quantum physics has been the most successful science in the entire history of Homo sapiens. However, the thought analogy helps us visualize the complexities when we get to the level of the extremely small, measurements can introduce more commonsense errors into experiments.

In classical physics, an assumption was made that measuring a phenomenon was non-intrusive. This worked relatively well for

certain large objects. Given certain topics and important assumptions for large objects, quantum physics validates classic physics as a limited case. However, the mistake of classic physics was to make itself universal. In philosophy, we might analogously call that assumption a 'metaphysic'. Why? We assumed in classic physics that observing a phenomenon was that of an impartial observer, sort of like God seeing humanity but not intervening for the sake of 'free will'. It turns out that there is no eye of God for us in our universe. Anything we try to measure or observe will have an effect on what we are looking at. When the effect of a measurement is small, classic physics generally works with negligible observational interference on the object studied. However, if what we are looking at is something very small, as in quantum mechanics, it is possible to observe what is happening with a huge club not a finely tuned microscope. In some cases, this is the plain and simple reason why we cannot make any definitive statement about whether a photon, for example, is a particle or a wave.

That being stated, beyond this quantum physics tells us non-resolutely that contradiction is not an absolute reason for dismissing results which have been proven to be contradictory unless one insists on maintaining a belief that classic physics based on noncontradiction is universally true. In classical physics both statements about quanta being particles and waves cannot be true. This was recognized all the way back to the beginning of the 19th century when Thomas Young discovered the wave behavior of light. At that time, it was thought that light must be either particle or wave. It was not conceivable to them to think of light as both particle and wave. Twentieth century physics calls the wave-particle principle of quanta the complementarity principle. [171] For a complementarity principle both statements can be true and contradictory without having to find a classical resolve. The major philosophical shift indicated by Heisenberg and Bohr earlier tells us to leave behind the Latin idea of 'nature' we inherited and think more in terms of 'what is the phenomenon itself' telling us? The

complementarity principle mimics a saying in the new 20th century philosophy of ‘phenomenology’ with its motto ’back to the things themselves’ rather than abstract and historic principles of logic. The complementarity principle gets used over and over again in quantum physics.

The complementarity principle applies to very many other kinds of observations that cannot come under the simple category of objective observation without interference. We think of photons as waves, but they are equally particles. You can set up a double-slit experiment where you send a photon through them which will make an interference pattern on a screen from which we conclude that light is a wave. However, if you put small photon detectors on each slit to see which slit the photon ‘really’ went through you might be inclined to think that the slit’s detectors were a ‘hammer’-like mechanism which impacted the interference pattern. Similar to the moon analogy, here is how that reasoning goes.

The mechanism of the detectors is a club for the photon, and you see one small blurry dot on the detector from which we conclude that the photon is a particle. This is because, like a tsunami, you wash any wavelike phenomenon away with the detectors. However, to eliminate this possibility John Wheeler (1911–2008) later proved in his delayed choice experiment that extracting "which path" information after a particle passes through the slits can seem to retroactively alter its previous behavior at the slits. [172] If the detector itself changed the interference pattern, then altering the observation of the particle/wave after passing through the detectors would not impact the prior source of the interference pattern. There are also subsequent experiments which show that while it may be more tempting to assign a cause-and-effect impact from the measurement to maintain a classical orientation to complementarity, which has been disproven to the satisfaction of almost all contemporary physicists.

The complementarity principle can also apply to very large objects like blackholes. Put simply, there are two schools of thought

about what happens to someone if they were to fall into a blackhole. One school of thought says you will hit a fiery wall at the event horizon that will tear you into subatomic particles. The 'hammer analogy' way of thinking tells us if we were to look at someone approaching a blackhole, the laws of physics would require using a very high powered, high frequency form of radiation to see what would happen to someone when they hit the event horizon. The intensity of this radiation would be like a mega-microwave oven. What you would see is the person disintegrating due to the radiation you are blasting them with. You could never see what really happened as if you were an impartial observer.

Here is a quick look at blackhole complementarity. The other school of thought says you will go through it as if nothing happened. This school of thought tells us from the perspective of the observer going into the blackhole they would not notice anything different at all as they entered the blackhole, they would just sail right through. This is because blackholes do not just swallow up things in space they actually devour spacetime itself called frames along with everything in the spacetime frame. At the event horizon the entire frame gets entangled with zero-point energy or vacuum energy at the event horizon. More on that later. This is called frame dragging. In this case if the entire earth were swallowed up by a supermassive blackhole nothing would seem different for a while. It is sort of like saying that the size of everything just increased by two so how would you know that it increased by two? [173] But from the point of the observer outside the blackhole watching the other observe fall into the blackhole they could never see what happened to the observer that went into the blackhole. The observer outside the blackhole would never know what happened. The reason for this is because the observer outside the blackhole in another relative frame would see the earth going towards the blackhole but it would go slower and slower and simply stop forever at the entrance of the blackhole. Our relativistic frame is limited by the speed of light and anything going into the

blackhole's event horizon would violate the speed of light limit in our universe. All the math denies us even the possibility of ever knowing for sure what would happen. This again is yet another example of complementarity. Ambiguity and uncertainty are essential to current physics. It is us who have to change our insistences on fantasies of a classical universe which is totally deterministic and consistent. We have been brought essentially to a nagging question by current physics which makes us uncomfortable. Our metaphysical notions about reality make us uncomfortable, not the phenomenon itself. The point here is that over and over again we are going to run into the complementary principle. When we run into these situations, the answer is both are true, and both are contradictory. This is because there really is no such thing as an impartial observer. Einstein said, "God does not play dice with the universe!" Bohr told Einstein, "Who are you to tell God what to do?"

Symmetry and Infinities

The assumption of symmetry when we are not looking is a dominant theme in classical physics.

> The term "symmetry" derives from the Greek words sun (meaning 'with' or 'together') and metron ('measure'), yielding summetria, and originally indicated a relation of commensurability (such is the meaning codified in Euclid's Elements for example). It quickly acquired a further, more general, meaning: that of a proportion relation, grounded on (integer) numbers, and with the function of harmonizing the different elements into a unitary whole. From the outset, then, symmetry was closely related to harmony, beauty, and unity, and this was to prove decisive for its role in theories of nature. In Plato's Timaeus, for example, the regular polyhedra are afforded a central place in the doctrine of

> natural elements for the proportions they contain and the beauty of their forms: fire has the form of the regular tetrahedron, earth the form of the cube, air the form of the regular octahedron, water the form of the regular icosahedron, while the regular dodecahedron is used for the form of the entire universe. The history of science provides another paradigmatic example of the use of these figures as basic ingredients in physical description: Kepler's 1596 Mysterium Cosmographicum presents a planetary architecture grounded on the five regular solids.[174]

One note here, Cartesian coordinates and Euclidean coordinates are often used interchangeably, but they are not the same thing. Cartesian coordinates are a coordinate system that uses perpendicular axes (x, y, z) to define the position of a point in three-dimensional space. Euclidean coordinates, on the other hand, refer to the geometric space that follows Euclid's axioms. In other words, the Cartesian system is Euclidean space with coordinates. The Cartesian Coordinate System unified geometry and algebra into one system of analytic geometry. [175]

Einstein's relativity is based on symmetry.[176] Here are some ancient arguments for symmetry:

> Buridan's ass: situated between what are, for him, two completely equivalent bundles of hay, he has no reason to choose the one located to his left over the one located to his right, and so he is not able to choose and dies of starvation.
>
> Archimedes's equilibrium law for the balance: if equal weights are hung at equal distances along the arms of a balance, then it will remain in equilibrium since there is no reason for it to rotate one way or the other about the balance point.
>
> Anaximander's argument for the immobility of the Earth as reported by Aristotle: the Earth remains at rest since,

> being at the centre of the spherical cosmos (and in the same relation to the boundary of the cosmos in every direction), there is no reason why it should move in one direction rather than another. 177

Leibniz's argument called the Principle of Sufficient Reason tells us that if there is no sufficient reason for one thing to happen over another then nothing will happen. Only an idiot of quantum physics would maintain any difference, right? Umm, well we did have accidents in Aristotle, but they were historically minimized to be exceptions which were ancillary to the rules. How much does narrative, personal, historic, cultural, linguistic account for our certainties of Latin's *natura*? Ah, but our, yet again, historic answer to that is, 'the only alternative is pure subjectivity, narcissism'. That would be a historic answer as well. Certainly, that pole of the binary duality of subject versus object colors any further speculation as superfluous. But history provides another answer as well, there may be more to the topic that we have yet ventured to undertake.

Even though we know it is highly probable that other 'laws of physics' are at work in other 'universes', blackholes, dark matter and energy in our own universe, we still maintain universally that 'laws' are at work underneath all the covers. However, whenever we observe a quantum wave function, we break symmetry. Observing could mean introducing an electromagnetic field to measure the position of momentum of a particle. Once we break symmetry, we no longer have a linear, continuous, probability of an 'ideal' expectation of where a particle will be. We introduce non-linearity in breaking symmetry. Physicists and all of us have a bedrock assumption that nature has symmetry and determinism. We assume that whether we are looking at something in nature or not looking at something in nature does not affect the continuous autonomic functioning of nature. But what if it does?

What if symmetry is a narrative of history, we tell ourselves? If

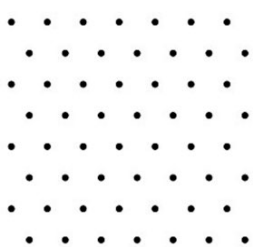
that were so, where do we get this idea of symmetry and the commonsense notion that nature always works quietly behind the scenes to adhere to strict laws of physics, biology, and evolution? In the 20^{th} century these were the stark questions facing Einstein and the founders of quantum mechanics. The proverbial thorn in everyone's side was finding no symmetry in nature which was independent of observation. On the smallest scales we found infinites of infinites which were not terminated in objectivity.

Physics and mathematicians have known for centuries that there are many kinds of infinities. Think about the set of all integers. We know that all integers continue infinitely in the positive and negative direction. So, there is an infinite number of integers. However, we also know that real numbers not only have an infinity of numbers in both directions but even between the smallest numbers like 0.1 and 0.1×10^{-22} there is another kind of infinity of numbers. We know there are infinite values in integers and at the same time we know that the infinite number of values in real numbers. And between every infinitesimally small number is infinite as well but somehow that infinite seems a lot larger than the infinity of integers. While both integers and real numbers have infinites, we cannot think that these infinities are all the same. Because of this, we have to quit thinking about all infinites as being the same and have to distinguish between different **kinds** of infinites. In quantum physics there are many kinds of infinities. By discerning these different infinities, we can make more accurate predictions and affirm or deny working theories of physics. Quantum mechanics is really the study of all these variations of infinites. One clear example of a different kind of infinity is the singularity of a blackhole. Infinities do not necessarily make intuitive sense but calculus as the mathematics of infinities has proven its usefulness over the centuries.

Quantum physics as the study of quanta assumes that at some extremely small level, nature has quanta, discrete packets of energy. This has been proven in particle accelerators all over the world. But

these particles defy our commonsense ideas of a particular ‘thing’. At the smallest levels of quanta, we see that nature does not give us a particle or a wave but a wavicle. We also see observing quanta at these levels changes what we are observing. The auto-normal processes of nature seem to yield to how we observe quanta. In other words, objectivity in a classical sense is not possible at these levels and neither is subjectivity. One important concept which often gets overlooked by non-physicists is that quanta are not immune from infinities.

In fact, quantum mechanics is intensely infested with mathematical infinites. Infinities are the rule rather than the exception in quantum physics. However, mathematics and physics have interesting ways of truncating some of these infinites as limits or as not relevant to a particular experiment after a certain point. Sometimes these infinites can be dealt with by renormalization.[178] A lattice is a mathematical description of an infinite set of points where any two additions or subtractions of points result in another point like this:



[179]

A lattice can be approximated with, for example, crystalline atoms, where atoms are arranged symmetrically. In condensed matter physics mathematical idealizations of composite materials (atoms) can be used as a starting point to approximate electromagnetic deformities in fields. The approximations can be used to renormalize or truncate infinities which pop up everywhere

in physics to simplify mathematics and make such implementations as quantum bits (qubits) possible.

> Renormalization specifies relationships between parameters in the theory when parameters describing large distance scales differ from parameters describing small distance scales. Physically, the pileup of contributions from an infinity of scales involved in a problem may then result in further infinities. When describing spacetime as a continuum, certain statistical and quantum mechanical constructions are not well-defined. To define them, or make them unambiguous, a continuum limit must carefully remove "construction scaffolding" of lattices at various scales. Renormalization procedures are based on the requirement that certain physical quantities (such as the mass and charge of an electron) equal observed (experimental) values. That is, the experimental value of the physical quantity yields practical applications, but due to their empirical nature the observed measurement represents areas of quantum field theory that require deeper derivation from theoretical bases.[180]

Later I will discuss quantum computing in more detail, but many folks have heard of the qubit. The qubit is a result of renormalization. That is, the qubit is a way of shortcutting infinites to provide useful information from phenomenon which intrinsically is immersed in a sea of infinities. I like this explanation,

> In particular, the quantum particle is literally “pulled out of its pointlike seat” by the field and that's more and more relevant the closer we get to the original point. This happens because the free electron is free only as long as it has no electric charge. When you turn the electric charge on, you allow for all quantum effects. So near the electron you find virtual electron-positron pairs, muons-anti-muons, quarks-

antiquarks (all flavours, all colours), etc. So now the electron has a structure, which means it has a spatial extension and occupies a region. It's no longer pointlike! But damn, I still want to handle it as the single particle I can measure and not as the plethora of loops and virtual particles! The latter is actually what physically tames the infinity. A real electron brings with itself the whole universe of elementary particles with their interactions and we know from experiments that this universe sums up to 511keV of energy, nothing less, nothing more (more details to come in the next lines). The mathematical renormalization procedure wraps all the physics that happens inside a certain cutoff radius (i.e. momentum) into a single term and calls it "the renormalized electron mass". Of course, there's no special value of the radius, and the procedure must be designed in such a way that in the end the radius can disappear from the result. In doing so, you will have all virtual particles disappear and get only their net effect. In other words, renormalization is able to provide you with effective masses, couplings and fields, which you can use as long as you give up probing the details of the structure of the particle-field coupling. So this effective particle is what you can measure and experience. But there's a price to pay for this simplification: you have to specify the exchanged momentum for which you want to get the effective mass, field and coupling! You wanted to treat the electron as a pointlike particle and that's possible provided you tell "how close to the centre" you are going.[181]

The bottom line is that quantum mechanics has an infinity problem but has effective strategies for getting around it to provide useful work. So, symmetry is a pragmatic necessity, but it is not the 'essence' of 'reality'. We already know that nature does not like our insistence on either waves or particles. And additionally, we have piled many more 'complementarities' over and above the wavicle

some of which will be discussed later. Is there more to this story? ‘Reality’ is much more uncertain and messier than anyone ever dreamed. What are the ramifications of this?

To add insult to injury, there is something called spontaneous symmetry breaking which propagates the idea that symmetry breaking happens in nature autonomously. Spontaneous symmetry breaking is how we have mass. It is the origin of mass. This will be discussed in more detail later. So, not only our observations but nature itself continuously, eternally, breaks its own symmetry in innumerable branches which can never be known and really boggles the mind just thinking about it. Here is a bit of a technical explanation but I hope you get the gist of it,

> Spontaneous symmetry breaking is a spontaneous process of symmetry breaking, by which a physical system in a symmetric state spontaneously ends up in an asymmetric state. In particular, it can describe systems where the equations of motion or the Lagrangian obey symmetries, but the lowest-energy vacuum solutions do not exhibit that same symmetry. When the system goes to one of those vacuum solutions, the symmetry is broken for perturbations around that vacuum even though the entire Lagrangian retains that symmetry.[182]

This Stanford article gives three possible technical reasons for symmetry breaking in physics. Simply put symmetry can break in at least three different ways because of inadequate knowledge, anomalies, or because of renormalization. Mathematical symmetry may produce some usefulness in certain situations. However, it may also obstruct another relevant phenomenon. Physicists think of mathematical symmetry as ‘invariant’ under certain conditions. But the idea of absolute symmetry which has no invariance is a metaphysic of history.

(a) Symmetry-breaking terms may be introduced into the theory by hand on the basis of theoretical/experimental results, as in the case of the quantum field theory of the weak interactions, which is expressly constructed in a way that manifestly violates mirror symmetry or parity. The underlying result, in this case, is parity non-conservation in the case of the weak interaction, first predicted in the famous (Nobel-prize winning) 1956 paper by T. D. Lee and C.N. Yang.

(b) Symmetry-breaking terms may appear in the theory because of quantum-mechanical effects. One reason for the presence of such terms — known as "anomalies" — is that in passing from the classical to the quantum level, because of possible operator ordering ambiguities for composite quantities such as Noether charges and currents, it may be that the classical symmetry algebra (generated through the Poisson bracket structure) is no longer realized in terms of the commutation relations of the Noether charges. Moreover, the use of a "regulator" (or "cut-off") required in the renormalization procedure to achieve actual calculations may itself be a source of anomalies. It may violate a symmetry of the theory, and traces of this symmetry breaking may remain even after the regulator is removed at the end of the calculation. Historically, the first example of an anomaly arising from renormalization is the so-called chiral anomaly, that is the anomaly violating the chiral symmetry of the strong interaction.

(c) Finally, symmetry-breaking terms may appear because of non-renormalizable effects. Physicists now have good reasons for viewing current renormalizable field theories as effective field theories, that is low-energy approximations to a deeper theory (each effective theory explicitly referring only to those particles that are of importance at the range of energies considered). The effects of non-renormalizable

> interactions (due to the heavy particles not included in the theory) are small and can therefore be ignored at the low-energy regime. It may then happen that the coarse-grained description thus obtained possesses more symmetries than the deeper theory. That is, the effective Lagrangian obeys symmetries that are not symmetries of the underlying theory. These "accidental" symmetries, as Weinberg has called them, may then be violated by the non-renormalizable terms arising from higher mass scales and suppressed in the effective Lagrangian.[183]

Again, Stanford tells us,

> Spontaneous symmetry breaking (SSB) occurs in a situation where, given a symmetry of the equations of motion, solutions exist which are not invariant under the action of this symmetry without any explicit asymmetric input (whence the attribute "spontaneous").[184]

This is another way of saying, 'shit happens'. Certainly, we can always assume that there are 'hidden variables' or symmetries which will eventually explain everything and satisfy our historic need for reason. But what if this kind of modern 'Greek cheerfulness' overestimates even the possibility of reason? What would it mean to think an excess of our historic determinations without on one hand giving ourselves over to another historic determination of apathy and cynicism, purely 'subjective' and on the other hand a fantastical delusion of the individual's heroic Darwinian grandeur, perhaps another avenue of Nietzsche? For me, countering these simplicities is the aim of this book. To the contrary, many have speculated that spontaneous, random, symmetry breaking could be the basis for emergence as for example in evolution. Emergence involves three ideas: symmetry breaking, randomness, and accident. Emergence is important especially in

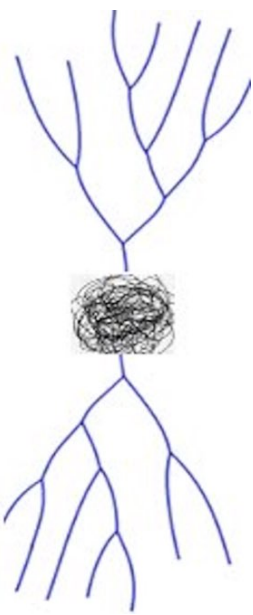
terms of biology and life and will also be discussed later.

Von Neumann proposed that there are two contradictory processes of the quantum wave function which are consistent with Heisenberg.

> The probabilistic, non-unitary, non-local, discontinuous change brought about by observation and measurement...
>
> The deterministic, unitary, continuous time evolution of an isolated system that obeys the Schrödinger equation (or a relativistic equivalent, i.e., the Dirac equation). 185

That will be the subject of the next major section.

THE QUANTUM WAVE FUNCTION



Quantum Wave Function Branching from Chaos 186

At the start I want to make some jargon clear which can be confusing for newbies in quantum physics. There are two strains of

physics, classical and quantum. Both of these are very different from each other. However, analogies can be drawn about quantum physics from classical physics which makes it easier for most folks to understand. Classical physics is the world of cause and effect, space and time, reality, existence, and commonsense. Nevertheless, quantum physics has a very hazy relationship to all these commonly accessible notions. Quantum physics is nonclassical. The quantum wave function is mathematical but also has a very odd and hazy relationship to all those commonly accessible notions of classicism. I use the word classicism to mean both classic science and philosophy. The vast differences between classicism and quantum physics are stark challenges to both science and philosophy. Quantum physics inseparably joins science and philosophy in a way we have not seen since the earliest intuitive beginnings of ancient civilizations. As we will see, the earliest pioneers of quantum physics Einstein, Schrödinger, and Bohr at the start of the 20th century acutely understood the implications of their findings for philosophy. They were all highly knowledgeable about philosophy. They and many others after them were well aware of the wide-ranging repercussions of their work which necessitated their thinking and ample writings on philosophy.

Additionally, the words ‘particle’ and ‘wave’ need some context. In quantum physics, particles (such as electrons, protons, and photons) exhibit both wave-like and particle-like behavior. Their wave-like properties are described by wave functions, which encode probabilities of finding the particle at different positions. But one important point to note here, by ‘wave’ function this does not imply any kind of ‘wave’ we have ever seen. Even more, it is impossible to think of ‘wave’ in this context as anything physical. The wave function itself is not physical. It is described probabilistically by mathematics. The word ‘wave’ is used analogically because the wave function has some mathematical similarities with fluid dynamics. However, the difference between waves in the ocean and waves in the quantum physics is unimaginably different. And since

the wave function isn't physical, the word 'particle' also has similar issues. The particle-like aspect typically refers to localized behavior in spacetime after wave function collapse. The implication is that after wave function collapse it is as if they were tiny, indivisible entities. But even that is problematic. Particles after collapse are tiny concentrations of energy which have more or less (somewhat) clearer defined energy levels within a certain extremely small region of spacetime. However, even these boundaries are somewhat artificial as these energy levels can have decreasing energy all the way out to infinity. Before measurement, a particle's state is described by a wave function, which can be a superposition of different states. When measured, the wave function collapses to a specific state (eigenstate) corresponding to the measured observable (e.g., position or energy). This collapse occurs due to the interaction with the measuring apparatus. However, the term "particle" is used both before and after measurement. After measurement, the particle's position (or other property) becomes more definite. But even before measurement, the particle's wave function encodes probabilities of different outcomes. The particle's behavior is a blend of wave-like and particle-like aspects until observed. In everyday language, we often refer to particles as localized entities (e.g., an electron or a photon). This colloquial usage doesn't necessarily imply wave function collapse. Scientists use the term "particle" more broadly, encompassing both pre-measurement and post-measurement states. The term "particle" is used in various contexts, and its meaning depends on the level of detail and the specific context of discussion.

In quantum theory there is a randomness, which I have called chaos, which cannot be avoided. This randomness is called the observer effect. There is no way to think of quantum physics in terms of 'objectivity' as in classical physics. There is no way to bracket the effect of the observer. Quanta wants to interact with its environment, and it knows nothing about separate objects which are discrete 'things'. This is the first idea we need to lose if we want

to understand quanta. Quantum wave/particles cannot be separated. They are incessantly forming in multiple different degrees entangled systems. This includes the observer, any measurement, any detector, nothing is excluded. When quanta act as a system, they can be completely described by the quantum wave function given enough information about the system. But if an observer wants to look at the individual parts of the system in isolated from the system the parts revert to chaos or randomness.

The quantum wave function lurks spookily behind-before-through all our universals, everything, and anything and more. It can be truncated and isolated from the entire environment to a degree to give us probabilistic approximations culminating in the highest and most spectacular understandings of *phusis* we have ever achieved. But this is not just smoke and mirrors. There is an excess to hocus-pocus. The overall wavefunction - describing the measured object and measuring detector - evolves in a completely predictable way. Each time we repeat the experiment, this overall wavefunction will behave in exactly the same way, and its evolution can be predicted probabilistically by the well-defined laws of quantum wave mechanics. Typically, we think of a detector as measuring a system of quanta like for example an atom's behavior. But predictability in quantum mechanics does not allow that dynamic. The detector is always intrinsically a part of the system and cannot be isolated without reverting to chaos, indeterminacy, unpredictability. Even building more nuanced and complicated detectors does not solve the problem of chaos. It is important to understand that a system which can be made up of many 'systems' cannot be treated as separate systems. It acts as one coherent body which no longer retains any 'identity' as a sum of parts. This is the basis of emergence and even novelty which I will discuss later. When a system is entangled, which is another way of saying correlated in its environment, we cannot look at the parts separately, but we can look at the correlations of the system using the quantum wave function. 187

Correlation here does not mean we can only have one possible outcome or measurement. We can have multiple, probabilistic outcomes and measurements. Actually, there can be an infinity of probabilistic outcomes, but we can still determine the most likely outcomes using the wave function. The wave function divides the world of quantum physics from classical physics. The wave function is thought to be deterministic if all information were known. There is only one wave function, and it is for the entirety of existence and anything else which may not conveniently fit into binary dualisms of existence and non-existence. As such, the wave function is nonclassical. This nonclassical condition is known as an odd form of 'superposition'. However, anytime we want to use the wave function we must interact with it as a part of the system. We become a part of the system by merely asking for information on another part. The system itself has already accounted for us interacting with it but when we employ the wave function to understand something we do so from existence as measurement or detection. This results in the system decohering. Decohering is referred to as collapse of the wave function according to the Copenhagen interpretation, state reduction, or reducing to a classical state. From the wave function in superposition, we decohere into 'reality', existence, Being, etc. As we shall see since the wave function in superposition has already accounted for our interaction with it, all possibilities have been realized but that may not mean seen from the perspective of [our] existence. This is a subject of many interpretations as we will see soon. The wave function in superposition assumes that it can evolve forward and backward in time. But actually, time is useful and even necessary but for the quantum wave function itself, it all happens simultaneously. However, once we observe the wave function in collapse or from the classical world there is no longer a possibility for going forward or backward in time as in superposition. Instead, the wave function has branched from our perspective into an un-retraceable step lost to the classical world. Not only that but all the

other possible branches which can be infinite become inaccessible to us, or the information is forever lost to us on these other branches. This is called 'many-worlds' theory but there is a lot more to it than the title suggests as we will see shortly.

The question arises from our history of noncontradiction. Where is the classical particle in superposition? If we must insist on an answer, we can only say that two answers exist,

1. When the observer is not looking (or the particle is not being otherwise detected), the particle is everywhere.
2. When the observer is looking (the particle is being detected), the particle "jumps into" a particular position state with a probability given by the wave function.

This is called state reduction or wave function collapse as given by the Copenhagen interpretation. To illustrate this interpretation, consider the simple, two state case of a particle that can occupy a small container either at x1 or x2. In classical physics, we assume the particle is located either at x1 or x2 when the observer is not looking. However, in quantum mechanics, the particle may exist in a state of indefinite position—that is, it may be located at x1 ***and*** x2 when the observer is not looking. The assumption that a particle can only have one value of position (when the observer is not looking) is abandoned. Similar comments can be made about other measurable quantities, such as momentum and energy. So, in asking where exactly the particle in the superposition state is, there are two answers. When an observer is not looking, the particle is not being detected, the particle is everywhere from minus infinity to positive infinity. When the observer is looking, the particle is being detected, the particle jumps into a particular position state with a given probability. In classic physics we assume that the particle is still 'there' when we are not looking at it. But quantum mechanics upends this idea altogether with the proven idea that the particle is in an indefinite, indeterminate state. This applies to all properties

such as position, energy, momentum, etc. Effectively, this means not classically ontological or epistemological. In other words, without any relationship positive or negative to The reductive idea we think of as 'reality'. And, without any relationship to our classical ideas of truth and falsity. The indeterminate state vastly exceeds our historic conceptual capabilities for understanding. The only alternatives available to classical understanding end up in equivocations of the same. Our logic does not suffice as it cannot find its own limits in superposition. We call this the 'inability to be able' in Levinas.[188]

It is important to understand that the quantum wave function operates over waves in superposition. In quantum physics, a wave function (often represented by the Greek letter Ψ) is a mathematical description of the quantum state of an isolated quantum system. But there is a hazy complication to the indeterminateness of superposition. There is no 'there' in superposition for the particle but under highly restrictive environmental constraints we can make very good predictions about waves. If the quantum system can be sufficiently isolated some information about the waves in superposition can be known and temporal changes during superposition can give us deterministic, albeit probabilistic information about places a particle might exist upon observational collapse into a classical state. In the Copenhagen interpretation of quantum mechanics, the wave function is a complex-valued probability amplitude. It encapsulates information about the system's position, momentum, energy, and other observables. For example, the wave function gives us a calculated value in superposition of the probable location in space of where an electron might be found upon measurement, wave function collapse. Both before and after measurements quanta are in superposition. Only upon measurement does quanta take on specific values. In classical physics it was assumed that at the most fundamental level of physics, specific values for space and time were always the case. This gave rise to classical ideas in history from philosophy, physics,

and religion, that the notions of absolute realties were objective. In modernism a recurrent theme was that absolute reality was based in the senses. This notion of subjectivity languished in these histories until the 20th century when phenomenology and postmodernism began challenging these histories concurrent with the advent of relativity in the 20th century.

Quantum superposition states that if a physical system can be in multiple configurations (arrangements of particles or fields), the most general state is a combination of all these possibilities. Each configuration is specified by a complex number. For example, if there are two possible configurations labeled as 0 and 1, the most general state would be a probabilistic linear combination for each of these configurations. The probabilities for various measurement outcomes can be derived from the wave function. The square of the absolute value [189] of the wave function, denoted as $|\Psi|^2$, represents the probability density. Specifically, $|\Psi|^2$ gives the likelihood of finding a particle at a particular position in space upon wave function collapse or measurement. Here is an example of how temporal changes might occur while in superposition. An electron might deteriorate into a constituent particle like a photon and recombine to form another particle like a gluon all happening in superposition. The actual word 'superposition' in quantum physics simply means a simple linear addition of all possible wave states. that the squares of the absolute values of each one of these transitional changes can be *added* together to get a calculated probability density. Quantum superposition states that if a physical system can be in multiple configurations (arrangements of particles or fields), the most general state is a combination of all these possibilities. Each configuration is specified by a complex number. But first as a simple example, if there are two possible states or configurations labeled as 0 and 1, the most general state would be a probabilistic linear combination of both of these configurations. The probability density of say, where an electron might be found, is what happens upon measurement. Measurement is called the

observer effect. This is where the spooky alterity of superposition collapses into classical form. Classical form does not exist in superposition. Once a measurement is made collapsing the wave function, we can compare the actual value with the probabilistic calculated value. For physicists, the idea of temporal changes while in superposition means that through all kinds of states or configurations which might occur while in superposition, the probabilities calculated by the sum of all the absolute squares of the waves added together is *conserved*. What does this mean?

When we measure a physical quantity (e.g., position), the probabilities are related to the calculations of the wave function. According to the superposition principle, we can add and manipulate wave functions to form new ones. The Schrödinger equation governs how wave functions evolve over time. Qualitatively, wave functions behave like other waves (e.g., water waves or waves on a string). The wave function depends on '*degrees of freedom*'. **Degrees of freedom are intrinsic properties like position coordinates, momenta, spin, etc.** These intrinsic properties are said to commute meaning traveling or journeying to a destination. The word 'evolution' is used to mean how the Schrödinger equation governs how wave functions evolve over time. But using the word 'time' here does not connote an underlying phenomenon like classical temporality. This will be discussed later but 'time' for the wave function is simultaneous. Our view of the quantum wave equation as time evolution refers back to our classical perspective from which we must peer into its void (more specifics later). Qualitatively, wave functions exhibit behavior similar to other waves (e.g., water waves or waves on a string).

The quantum wave function is linear. When we say it's linear, we mean that if we have two solutions to the Schrödinger equation (let's call them ψ_1 and ψ_2), then any linear combination of these solutions is also a valid solution. This linearity property allows us to construct more complex wave functions by combining simpler ones. Remember eigenstates? Eigenstates are idealized conditions of

particular particles' behavior. In superposition multiple eigenstates can be added together to give us an eigenstate's probable property's value upon measurement. Here is a more exact definition of a linear operation:

A function f is called a linear operator if it has the two properties:

$f(x + y) = f(x) + f(y)$ for all x and y;

$f(cx) = cf(x)$ for all x and all constants c.

It follows that $f(ax + by) = af(x) + bf(y)$ for all x and y and all constants a and b.[190]

Physical systems meaning actual measured values or observed values are generally not linear but, depending on the system, physical systems can be approximated as a linear system within certain ranges or bounds. When it comes to actual values statistical measurements, meaning measuring the values over a multitude of times, generally gives us a better idea of a more reliable value.

The quantum wave employs complex valued, real and imaginary vectors, to produce probabilities of possible measurement results on a given quantum system. The wave function produces degrees of freedom which aim at maximal ranges or limits for dynamic observables. The wave function may tell us a probable range of all particle position coordinates in a given quantum system. It could give us a probable range of momenta over a momentum space. Some particles have spin so the wave function can give us ranges or degrees of freedom for such particles. Some particles have internal degrees of freedom which may not affect the external environment but can play a role in determining internal dynamics of a quantum system. The wave function can also reveal these probable limits as complex values.

Complex values contain a real value and an imaginary value. Don't get spooked over imaginary values. An imaginary value is used because some operations or work cannot be computed under certain conditions or with certain constraints. The imaginary value gives us conditional requirements which can be useful for

operations and/or perhaps exert influences on the ‘real’ value for certain kinds of other operations. Think of division by zero. We call that undefined. Division by zero is always undefined. However, in science there are times when a function is useful for predicting some outcome but not useful for other outcomes. An imaginary number is defined as the square root of minus one symbolized as ‘i’. By default, the square root of a negative number does not make sense. It is undefined because square roots only make sense for positive numbers. On the other hand, you can square or multiply the square root of minus one by itself and get one. So, in some operations the undefined operator of the square root of minus one will not be a problem and yield a defined result. A complex value could simply look like 1 + 4i. This function by itself does not make sense in terms of real numbers but we could take the squares of a real value and a complex value and still get a real value. Let’s take a real value and an imaginary value like -> 1 + 2i. We still retain the ‘i’ to remind us that the imaginary number is still imaginary. We can square the real value and the imaginary value to get 1^2 + (2^2 times i^2) = 5. Because ‘i’, the square root of minus one squared is simply 1, the ‘i’ goes away and we simply get a real value of 5. Both the real value and the complex value might not be a value at all. The real part and the imaginary part could be multidimensional vectors and even another function or operator. Typically, in physics, these values are complex vectors or functions (operators). As you can see, both the real and imaginary parts contribute to the number's *magnitude*.

Superposition is a complex-valued operation performed on a linear system where the presumption is that, for certain operations in certain ranges, the sum of all the individual parts of a system produces a composite result. Superposition in quantum mechanics allows multiple wave functions, a n-dimensional complex vector space of wave functions, to be added together to form a new wave function. Even more, if there are many particles in a system there aren’t separate wave functions for each particle. In this case, there

may be only one wave function for the entire system. This is also what makes quantum entanglement and the EPR paradox possible. Let's recall the Einstein, Podolsky, and Rosen's EPR paradox[191] tells us that a particle is a wave and a particle and depending on how we look at it is how it 'is'.

The Schrödinger (1887-1961) wave equation was a paradigm change in quantum physics.

> The Schrödinger equation is a linear partial differential equation that governs the wave function of a quantum-mechanical system. Its discovery was a significant landmark in the development of quantum mechanics. The equation is named after Erwin Schrödinger, who postulated the equation in 1925 and published it in 1926, forming the basis for the work that resulted in his Nobel Prize in Physics in 1933. [192]

Conceptually, the Schrödinger equation can be conceptualized as the quantum mechanical version of Newton's second law of motion which describes what path a physical system will take over time. The Schrödinger equation gives the evolution over time of a quantum wave function. The quantum wave function can be visualized as particles which are waves or wavicles which have a time evolution operator. [193] Different schools of thought on how to interpret the wave equation will be discussed a little later. As mentioned earlier, ontology in philosophy asks about existence, being, or reality. The wave equation coupled with the Born rule hovers in some odd fashion between reality, its observational capacity to shape reality itself, and just plain ol' spookiness.

> Whether the wave function really exists, and what it represents, are major questions in the interpretation of quantum mechanics. Many famous physicists of a previous generation puzzled over this problem, such as Schrödinger, Einstein and Bohr. Some advocate formulations or variants of

> the Copenhagen interpretation (e.g. Bohr, Wigner and von Neumann) while others, such as Wheeler or Jaynes, take the more classical approach and regard the wave function as representing information in the mind of the observer, i.e. a measure of our knowledge of reality. Some, including Schrödinger, Bohm and Everett and others, argued that the wave function must have an objective, physical existence. Einstein thought that a complete description of physical reality should refer directly to physical space and time, as distinct from the wave function, which refers to an abstract mathematical space. 194

Eigen in German is a prefix which means 'proper', 'characteristic, or 'own'. An *eigenvalue* can be a real value, zero, or a complex value. An *eigenvalue* can represent an infinite value limit like the speed of light. An eigen*vector* is an n-dimensional value. A wave function can be an *eigen*vector of an observable in which case it is called an *eigenstate*. *Eigenvectors* can be thought of as the idealized or pure value of an observable. Pure values rarely occur in nature, but they can be given a probability using the Born rule. 195 As we will see non-relativistic quantum mechanics can be thought of as states of idealized particles which have time evolution probabilities assigned to them under certain conditions.

Schrödinger's time evolution operator is deterministic, unitary, and continuous. How is this possible? In an idealized fictitious character, Pierre-Simon LaPlace (1749-1827) tells us that the universal wave function which would not be probabilistic and purely deterministic would only be visible to a demon which he whimsically called LaPlace's demon. Because, ONLY from the view of Laplace's demon or God where no emergent, novel, or new information is possible, Schrödinger's equation would evolve smoothly, continuously, absolutely deterministic, without any probabilities or changes due to new information. Schrödinger stated in 1952 that the evolution of his wave equation is not happening in

a piecemeal fashion but all at once. He said, "*not alternatives but all really happen simultaneously*." [196] Again, we are talking about the many-worlds interpretation to be discussed a little later. For now, this interpretation formulated in 1956 holds that all the possibilities described by quantum theory simultaneously occur in a multiverse composed of mostly independent parallel universes. It might be easy or intuitive to think of the Schrödinger equation as using the time-evolution operator to go from one discrete quantum state smoothly and continuously to another. However, for one thing these states are not static and discrete. They are consumed in the wave function as probabilistic and in informational branching as statistically realized.

Quantum empirical experiments are highly controlled, isolated from environmental leaks as much as possible, and in their simplest forms lack the complexities of chaotic systems. However, the really spooky thing is these simplistic forms which arrive at probabilistic temporal transitions into classical states give way to unpredictable and dynamic quantum complexity as evidenced by scars and quantum ergodicity to be discussed soon. While the wave function itself continues on through observation, our loss of information we think of as collapse or branching prevents us from falling back on metaphysics of an ‘original primal wave function’ beheld by the demon of LaPlace has more to do with the history of origin, rule, and authority than empirically based observation. In classical systems there is a phenomenon called ‘positive feedback systems’, like a microphone feeding back into an amplifier. An area of research in quantum systems is quantum feedback control. Stabilizing quantum states in superposition means looking for ways to use feedback to reduce ‘noise’ from quantum interference typically from the environment. One way of doing this is to characterize the noise and then devise ways to introduce ‘anti-noise’ to minimize the effects of unwanted information. Since quantum superposition is linear, this means intentional, additive, additional superposition states can be added while in superposition without

collapsing the wave function. Any form of information updating while in superposition such as an entangled system also provides feedback into *phusis'* conditioning what is perceived upon observation as a result. As in Schrödinger's 'Cat in the Box' thought experiment one observer observing what the previous observer saw continuously updates, changes, the informational history of what was in the box. But here is an interesting point, superposition seems to have a hazy relationship with spacetime.

In superposition we impose a continuous clock in the form of unitarity evolution. The question is, do we bring spacetime to the table when we explore superposition empirically? Spacetime itself is not typically described in terms of superposition. However, recent research suggests that within a unifying theory of quantum gravity, it might be possible to combine the notion of spacetime as emergent from quantum superposition. If this were the case, spacetime would not be the cause of superpositions but involve different configurations which are not related by global coordinate transformations. For example, when an electron is not detected, it isn't considered to be in a specific position in spacetime. Instead, it exists in a quantum superposition of probabilities. Physicists describe the electron as being in a "probability state," a "probability wave," or an "electron cloud" until measured. Unlike classical waves, quantum state amplitudes don't correspond to motion; adding identical states is not meaningful. When a quantum system can be in multiple configurations (different states), its most general state is a combination of all possibilities. In quantum physics, amplitudes play a crucial role in both classical waves and quantum systems, but their behavior differs significantly. Here are some differences:

Classical Waves:

- Amplitude in classical waves refers to the maximum displacement of a wave from its equilibrium position. It represents the energy carried by the wave.

- Classical waves, such as sound waves or water waves, follow Newton's Laws of Motion and can be described by simple mathematical equations.
- The relationship between amplitude and energy holds true for any wave that requires a material medium. For instance, the energy carried by a classical wave is directly proportional to the square of its amplitude.

Quantum Waves:

- In the quantum world, we encounter wave functions. These are complex-valued probability amplitudes that describe the behavior of quantum particles.
- Unlike classical waves, quantum waves do not necessarily require a material medium. They can represent the probability distribution of a particle's position, momentum, or other observable quantities.
- The amplitude squared of a quantum wave function provides the probability density for finding a particle at a specific position. It does not directly correspond to energy.
- Quantum waves exhibit phenomena like interference and superposition, which have no classical analog. For example, particles can exist in multiple states simultaneously, creating interference patterns.

While classical waves adhere to straightforward energy-amplitude relationships, quantum waves defy classical intuition. Superposition has this spooky sense of simultaneous, infinite branches of information. It is as if there was no particular past moving towards the future but somehow, we look into a window of superposition that already accommodates all infinite branches of information. Perhaps to some degree we must perceive temporality in our observation to even make sense of the quantum wave

function? Additionally, while the analogy of moving waves is useful pedagogically, quantum waves do not ‘move’ like water waves. Quantum waves seem to defy everything we think from our historic orientation of reality. It seems that what does not fit is exactly that notion of ‘is’, of ‘reality’. That is what is in question in superposition not how to hitch superposition to the spacetime cart.

Schrödinger and many other physicists stated that the easiest way to understand it is that all possibilities were happening simultaneously.

> In the views often grouped together as the Copenhagen interpretation, a system's wave function is a collection of statistical information about that system. The Schrödinger equation relates information about the system at one time to information about it at another. While the time-evolution process represented by the Schrödinger equation is continuous and deterministic, in that knowing the wave function at one instant is in principle sufficient to calculate it for all future times, wave functions can also change discontinuously and stochastically during a measurement. The wave function changes, according to this school of thought, because new information is available. The post-measurement wave function generally cannot be known prior to the measurement, but the probabilities for the different possibilities can be calculated using the Born rule. Other, more recent interpretations of quantum mechanics, such as relational quantum mechanics and QBism also give the Schrödinger equation a status of this sort.
>
> Schrödinger himself suggested in 1952 that the different terms of a superposition evolving under the Schrödinger equation are "**not alternatives but all really happen simultaneously**". This has been interpreted as an early version of Everett's many-worlds interpretation. This interpretation, formulated independently in 1956, holds that

> all the possibilities described by quantum theory simultaneously occur in a multiverse composed of mostly independent parallel universes. This interpretation removes the axiom of wave function collapse, leaving only continuous evolution under the Schrödinger equation, and so all possible states of the measured system and the measuring apparatus, together with the observer, are present in a real physical quantum superposition. While the multiverse is deterministic, we perceive non-deterministic behavior governed by probabilities, because we do not observe the multiverse as a whole, but only one parallel universe at a time. Exactly how this is supposed to work has been the subject of much debate. Why we should assign probabilities at all to outcomes that are certain to occur in some worlds, and why should the probabilities be given by the Born rule? Several ways to answer these questions in the many-worlds framework have been proposed, but there is no consensus on whether they are successful.[197]

With all this being stated, absolute determinism should again be emphasized as from the gods-eye, Laplace demon perspective. In my opinion, the interpretation of absolute determinism is more of a metaphysic. The practical, observational inability of the wave function to incapsulate all multiverse information defies spacetime and will tell us something important about chaos. I will get into Everett's many-worlds interpretation soon, but I want to briefly introduce his universal wave function.

The Universal Wave Function

In 1965 Hugh Everett's (1930-1982) PhD thesis draft was entitled, "The Theory of the Universal Wave Function." It is a basic component of the many-worlds interpretation of quantum mechanics. It is also used extensively in cosmology. Ultimately, it

provides a quasi-deterministic interpretation of the quantum wave function. Stephen Hawking and James Hartle used it to derive two very important solutions called the Hartle-Hawking solution and the Wheeler-deWitt equation, which have been used to explain the initial conditions of the Big Bang. The universal wave function tells us that observer and observed are mixed together in such a way that defy and exceed these classical binary dualities. Everett tells us that,

> If we try to limit the applicability so as to exclude the measuring apparatus, or in general systems of macroscopic size, we are faced with the difficulty of sharply defining the region of validity. For what n might a group of n particles be construed as forming a measuring device so that the quantum description fails? And to draw the line at human or animal observers, i.e., to assume that all mechanical apparata obey the usual laws, but that they are not valid for living observers, does violence to the so-called principle of psycho-physical parallelism. 198

In Everett's opinion, 'drawing the line' is not only all too human but finds no experimental evidence to show that exceeding the line causes the wave function to fail and thereby gives it bounds. Therefore, the simplest solution is that there are no bounds. Observer and observed, subject and object, order and disorder, etc. all presume a kind of 'ruling' or origin, and in Everett's words, violent truncation of something which vastly exceeds the scope of classicism. However, if the observer is indistinguishable from the observed it brings up a kind of koan for the mind. For example, if I make a physical determination in a quantum experiment and 'collapse' the wave function into classicism as the Copenhagen interpretation suggests, how do we account for the ability of the universal wave function to have, for lack of better words, already have known, taken account, of this before the observation was

made. In order for a universal, deterministic wave function to be universal it would defy our commonsense notion of absolute time. Another way of thinking this would be, how does the 'is' of time, existence, ontology, relate to any sense in which the universal wave function denies any sense of temporal intervention? Like Einstein's initial idea that the universe was static, the universal wave function would also have a sense of stativity (note: stativity is a grammatical property describing verbs, predicates, or situations that represent a static state, condition, or unchanging situation rather than a dynamic action. Stative verbs, such as *know*, *love*, or *belong*, generally do not take continuous/progressive (…*ing*) forms, as they describe enduring states, not actions.) . Even the idea of a stative verb is a point of contention with linguists,

> According to some linguistics theories, a stative verb is a verb that describes a state of being, in contrast to a dynamic verb, which describes an action. The difference can be categorized by saying that stative verbs describe situations that are static or unchanging throughout their entire duration, whereas dynamic verbs describe processes that entail change over time. Many languages distinguish between these two types in terms of how they can be used grammatically. [199]

Yet, a stative verb as a "state of being" is denied by the idea of the universal wave function which resists ontology, being, existence as determinate. So, the idea of a universal wave function has been used as an example of Pierre-Simon LaPlace's demon which was also used to justify determinism. [200] Due to this enigma John Wheeler suggests,

> One is led to recognize that a wave function 'encompassing the whole universe' is an idealization, formalistically perhaps a convenient idealization, but an idealization so strained that

> it can be used only in part in any forecast of correlations that makes physical sense. For making sense it seems essential most of all to 'leave the observer out of the wave function'. [201]

In other words, let's not ask these impossible philosophical questions, 'idealizations' and just pragmatically use the universal wave function in a physical sense which 'leaves the observer out of the wave function'. The only problem is that the 'physical sense' as empirically determined by experimentation has shown that the observer can in no wise be left out of the wave function. At least with regard to the Copenhagen interpretation of wave function 'collapse'. I will get into this more soon when I discuss interpretations of the quantum wave function.

The Born Rule

A primary assumption of the quantum wave function is dealt with in the Born rule given in 1926 with another updated one by Wheeler and Zurek in 1983. The Born rule is notoriously known as 'the measurement problem' in physics. Max Born (1882-1970) [202] said the correct way to interpret the wavy nature of quantum particles was as waves of probabilities. Schrödinger initially thought that particles were like waves and that the amplitude or height of the wave would be the smeared-out density of the particle wave. This turned out to be false. Instead, Born reasoned that the amplitude or height of the particle wave would give a probability for where the wave was. Born suggested that the right way to interpret the wavy nature of quantum particles was as waves of probability not like physical waves as, for example, water waves. Waves of probability are not physical. He was right, but he discovered it was really the "*at first Born thought that it was simply the amplitude of* ψ *that gave this probability. He quickly decided that it was the square of the wave function,* ψ*2 (or, strictly speaking, the*

square of its modulus, or absolute value)". [203]

However, Born's rule does not tell us anything about the particle wave if we are not looking at it. It is only when we look at it or measure it that it turns out to be consistent with Born's probability rule.

> In most physics equations, the variables refer to objective properties of the system they are describing: the mass or velocity of bodies in Newton's laws of motion, for instance. But according to Born, the wave function is not like this. It's not obvious whether it says anything about the quantum entity itself — such as where it is at any moment in time. Rather, it tells us what we might see if we choose to look. It points in the wrong direction: not down toward the system being studied, but up toward the observer's experience of it. [204]

This means that we are not looking at a particle doing its own thing regardless of whether we look at it or not. To the contrary, the particle *only* does its thing when we look at it. [205]

> "What makes quantum theory puzzling is not so much the Born rule as a way of computing probabilities," Chiribella said, "but the fact that we cannot interpret the measurements as revealing some pre-existing properties of the system."
>
> What's more, the mathematical machinery for unfolding these probabilities can only be written down if you stipulate how you're looking. If you do different measurements, you might calculate different probabilities, even though you seem to be examining the same system in both cases. [206]

What is meant here by "*stipulate how you're looking*" …nicely, angrily, etc.? Just kidding but in classic physics it would be unthinkable to preface every measurement with how you look at it.

Quantum physics is quite different.

> That's why Born's prescription for turning wave functions into measurement outcomes contains all of the reputed paradoxical nature of quantum theory: the fact that observable properties of quantum objects emerge, in a probabilistic way, from the act of measurement itself. "Born's probability postulate is where the puzzle really is," Cabello said. 207

So, if we want to be logical about it, forgetting about the hocus-pocus of having to look at it, what if we simply say that all possible outcomes happen simultaneously in many-worlds or branches when we observe them, and we lose access upon observation of all simultaneous outcomes for the sake of one observational classical outcome and be done with it? Or could it be that the Born rule is only given by the *original* observer's observation which assigns the correct probabilities an instant after the many-worlds split has occurred but before any other observers in the other worlds have registered the outcome of their measurement? This means just before the first observer observes using the Born rule many universes split off from each other. Then the first observer makes their measurement. Then, all observers thereafter will each see some version of all the rest of the possible measurement values. This way no one ever knows what universe had the first observer (say what?).

> One very different approach to deriving the Born rule draws on the controversial many-worlds interpretation of quantum mechanics. Many-worlds is an attempt to solve the puzzle of quantum measurements by assuming that, instead of selecting just one of the multiple possible outcomes, an observation realizes all of them — in different universes that split off from our own. In the late 1990s, many-worlds

> advocate David Deutsch asserted that apparent quantum probabilities are precisely what a rational observer would need to use to make predictions in such a scenario — an argument that can be used to derive the Born rule. Meanwhile, Lev Vaidman of Tel Aviv University in Israel, and independently Sean Carroll and Charles Sebens of the California Institute of Technology, suggested that the Born rule is the only one that assigns correct probabilities in a many-worlds multiverse during the instant after a split has occurred but before any observers have registered the outcome of the measurement. In that instant the observers do not yet know which branch of the universe they are on — but Carroll and Sebens argued that "there is a uniquely rational way to apportion credence in such cases, which leads directly to the Born Rule." [208]

Ok, this kind of rationale happens when you exacerbate the dickens out of physicists. But all of that kind of rationalizing tells us how far physicists have gone to try to find some rationale to explain away spookiness. You might think, so we have a lot more universes but who are these other observers anyway? Or why and how would all these other observers synchronize their observations in subsequent universes anyway? Don't they have something better to do? How do they get the cue to start in synchronicity? Perhaps it is more like when they get around to it kind of thing. Oh, but wait, we haven't even started talking about the nonexistence of time yet. But these are minor details when we are trying to de-spooky-fy "*multiple possible outcomes"* and how *"an observation realizes all of them*".

Another proposal called the Wheeler and Zurek contention is termed delayed choice where each particle decides, for example, if it is going to be a wave or a particle when it is emitted. This is also called retro-causation because the choice of each particle's measurement is retroactively, backwards in time, caused by the observer. This will be discussed more later but Wheeler and Zurek

do not subscribe to faster than light negotiations for particles to decide what they are going to be dependent on how they are being looked at…again, a lot of jumping through hoops on this one too.

In spite of all this, at least many-worlds give us an answer to how the Born rule works in existence instead of some abstract mathematical fantasy world. Hopefully, all this silly talk gives you an idea of what bothers the hell out of many physicists. While I do jest, as we shall see the many-worlds narrative actually does make more sense if we can call it that. If we allow the premise that observation is solely determinate of what probable value is observed and that there is no 'original value' before or after observation, we are left with the idea that all values must be available simultaneously.

I know what you are thinking. How is it that each one of us is not in a hallucination like the pods in the movie "The Matrix" or like the recent movie "Everything Everywhere All at Once"? To be more precise, the way the idea of many-worlds was originally formulated had nothing to do with many-worlds. Everett called it 'relative state formulation'. That is, observation is relative to the observer's own state or more precisely, the state of their records. But the many-worlds phrase is what came around later.[209] Quantum spookiness has been tested and tested and many have tried to explain it in other ways, but all have failed.

> The problem is that Born's rule was not really more than a smart guess — there was no fundamental reason that led Born to propose it. "It was an intuition without a precise justification," said Adán Cabello, a quantum theorist at the University of Seville in Spain. "But it worked." And yet for the past 90 years and more, no one has been able to explain why. [210]

The spookiness of the Born rule along with the quantum wave function will be discussed shortly. The many-worlds idea simply

and specifically applies to a certain prevalent interpretation of the quantum wave function which will be discussed in more depth soon. There is a necessary and intrinsic matter of degrees or statistical probabilities of quantum wave function 'collapse'. Recent history from the start of the 20th century has provided us with its many odd interpretations and mixtures of these interpretations. I will discuss all the major philosophical/physics (*phusis*) interpretations of the quantum wave function and Born's rule but for now I will give a brief comment on my interpretation.

One important point to clarify is that there are several notions at work historically in the many-worlds idea. One idea is that there are absolutely separate 'universes' with no relationship whatsoever to each other. The other idea is that ***all these worlds or universes overlap and are interwoven***. In this idea it may be possible to have a kind of metaphysics of choice in which the self always branches into all possibilities and choice in some odd way plays a determinate role in one's evolution.

Right at the start let's get this straight, by 'many-worlds' I personally prefer to think of it as some kind of spooky, other combination of what we refer to as individual narratives and collective narratives. At least it seems that the Born rule and the quantum wave function points directly and necessarily back to us, to our interpretations, in a different way than we are used to thinking about. I will continue to use the phrase many-words but in terms of physics and philosophic/religious history not in a literal sense which I think could only be some kind of metaphysics. There is no reason to exclude human psychology from the notions of narrative and interpretation (called hermeneutics in philosophy) of the quantum wave function. Relative to further discussions in this book, this might imply there is a spectrum of degrees from pathologically narcissistic personality disorders to dissociative or autistic loss of individuality to where functional, adaptive psychology falls in the balance of ego and sociological narratives. More on these ideas later but for now let's look a little deeper into

how the Born rule works.

Born connected the probabilities of possible results with what we think of as the quantum wave function. A typical result could be the probabilistic position or momentum of a particle in some region of space. Initially, a wave function is in superposition characterized by ideal states of multiple particles we now call an eigenbasis (remember *eigen* in German means 'characteristic' or 'particular') which collapses into some observable or the particles observed. When an external agency like an observer or experimenter measures the observable, the wave function collapses from superposition, the full ideal number of particles called the eigenbasis, to ideally just one of the basis eigenstates. However, collapsing to one ideal eigenstate never happens since 'ideals' are rare in actual experimental measurements. The Born rule gives spreads of probabilities called probability densities for the result of the collapse.[211] The Born rule was a lucky guess, no one knows why it works but it worked and has been working for the last 90 years.[212] The Born rule is non-deterministic because it is probabilistic and not fully determined by its actual, measurement.[213] In the actuality of measurement, its locality has a nonunitary quality because its actual measurement does not follow a smooth, continuous, classical unitary evolution of time forwards or backwards. In this sense the actual measurement is stochastic meaning having a random probability distribution. Actual measurement is discontinuous because the non-existence of it before and after measurement (we might call superposition as we will see) changes instantaneously in an indeterministic, probabilistic fashion (we will call decoherence). Decoherence is irreversible.

> A realist description of our universe requires a twofold concept of locality. On one hand, there are the strictly Einstein-local interactions which generate the time evolution. On the other hand, the quantum state space calls for a non-local description of multi-particle states. This article uses a

behavioristic approach to argue, that an observer in a universe like this has to rely on local interactions to learn about its properties and behavior. Such an observer is fundamentally restricted in his ability to understand and structurally reconstruct the individual local physical universe. We argue, that this reconstruction based on dynamically available information is the defining process of observation in quantum theory. The observer-centric view of the global quantum dynamics is shown to be non-unitary and non-linear in general, even if the universe itself evolves unitarily.

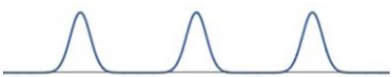
Interactions with massless free particles are found to have great influence on observation, because of their special role in the light-cone structure of an Einstein-local universe. For a specific scattering process with a photon of unknown state, the observed outcome can be subjectively random and follow the Born statistic, while the output state is really determined by the photon polarization. Based on this result, a theory of quantum measurement is formulated, which describes a measurement device as a cascade of scattering events. 214

The idealized eigenstates which collapse as ‘reality’ can only be realized in extremely tightly controlled experiments where the rest of the environment must be isolated in an extreme fashion. Quanta wants to interact oddly and intimately with everything. Without these highly controlled experiments, complexity grows towards an incredibly high limit which, for now, could be thought of as overflowing itself. In the same way the entropy in isolated systems grows towards a limit (we call thermodynamic equilibrium) complexity as information reaches a limit with its available degrees of freedom. We call this relative state environmental limit of complexity chaos. However, this is not the classical philosophical notion of chaos as absolute disorder. This is a spooky kind of chaos. However, there is no way to introduce the idea of chaos theory and

the quantum wave function without introducing emergence and novelty. In quantum physics, the concepts of emergence and novelty are essential for understanding quantum theory.

A Simple Example of Waveform Probabilities

Let's say we have an electron wave with three simple bumps equally separated and all with the same energy as in the diagram below,



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In this case when the electron is localized, meaning the wave function has collapsed into a classical particle state, we can see that the electron particle will have a one in three chance near one of the bumps. What if we have an electron with two unequal bumps like the diagram below,

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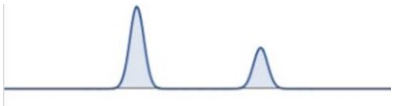
In this case the wave can be negative like the first bump and positive like the second bump. To find the probabilities of where the electron particle will be localized, we must first square the waves so that both waves will be positive. This is what happens when we square both bumps,



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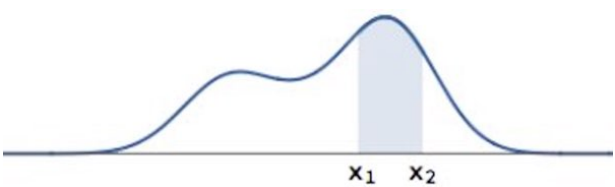
The total area under these squared bumps is one. This is because of the condition of discreteness for the wave in quantum mechanics. What is discreteness? In quantum physics, discreteness refers to the existence of individual “lumps” as opposed to a continuum. There are several forms of discreteness in quantum theory, including the discreteness of eigenvalues and the associated countable eigenstates. The concept of discreteness is fundamental to quantum mechanics and is one of the key differences between classical and quantum physics. In classical physics, all quantities are allowed to be continuous, while in quantum physics, certain quantities are quantized and can only take on discrete values.

If the right bump has an area of say 2/3 and the left bump has an area of say 1/3, there is a two out of three chance the electron will be near the right bump and one out of three chance the electron will be near the left bump. So, how would we calculate the probability density of where an electron might be in the case below,



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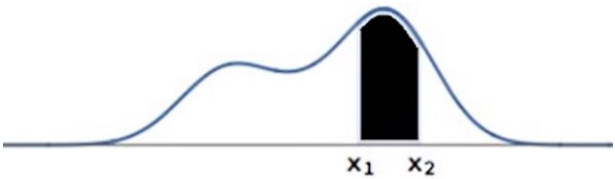
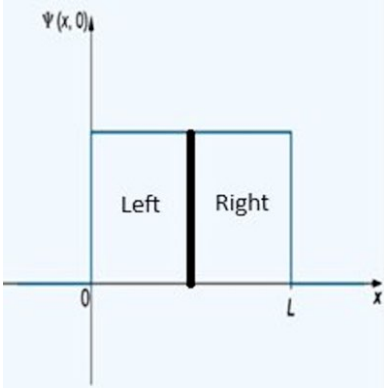
What is the probability density that the electron will get localized in the interval between x1 and x2? First, we square the wavefunction so the graph will be positive everywhere. We know by discreteness that after squaring the wave function the total area will be one. Calculus is made to find this area. For our purpose,

suppose the area in black is 0.66 or 66%. This means there is a 66% chance that the electron wave in superposition will get localized into a classical particle in the region between x1 and x2.



A Deeper Dive – An Example for Calculating the Probability Density of Finding a Ball

Let's say we have a ball which can move inside a straight tube of length 'L'. The ball is equally likely to be found anywhere in the tube at time 't'. What is the probability density for finding the ball in the left half of the tube? Well, that is easy 50% but let's look at how the wave function would arrive at this value. First, we need to write down the wave function. The graph below shows a graph corresponding to the ball in the tube and the single dimension 'x' in which the ball can travel. The 'y' direction is zero, so the wave function is $\Psi(x,0)$. We can assume that the wave function is normalized meaning the probability density of finding the ball in the area of the tube is one and that the ball classically (ontologically) exists when observed somewhere in the tube.



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In this situation the wave function can be written as $\Psi(x,t) = C(0 < x < L)$ where 'C' is a constant, 't' is normally time but in this case we can simply set the time to zero to simplify the equation, $\Psi(x,t) = C(0 < x < L)$ means that the wave function is given in the range from 'x' equal 0 to 'x' equal 'L' (length). Anywhere outside that range is zero since we know the ball is confined by the tube of fixed length (this can be written as $\Psi(x,t) = 0$ for anywhere outside zero to 'L'. As we previously saw, since we know that this function is normalized, meaning we know that the ball exists somewhere in the tube we can write the wave equation for this as,

$$1 = \sum_{x=-\infty}^{+\infty} |\psi(x)|^2$$

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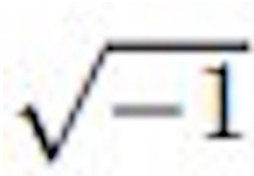
So, somewhere between minus infinity and plus infinity the probability of finding the ball will be 100% or one. Remember we square the wave so we can make sure all values are positive. More accurately, since the real wave equation will have 'complex' values it will have a real part and an imaginary part. The imaginary part is

represented as the square root of minus one which is undefined.



The only way to define it is to square the square root of minus one to get a real value (more on complex values later). Now we can say that the probability density 'P' for finding the ball from minus infinity to plus infinity is,

1. Zero from minus infinity ($-\infty$) to zero is 0
2. Zero from L to plus infinity is 0
3. A constant 'C' from zero to 'L'

This is written mathematically like this where 'dx' means the change in 'x' (the location),

$$P(\infty,+\infty) = \int_{-\infty}^{\infty} |C|^2 dx = 1$$

But since we already know that the ball exists somewhere between 0 and 'L' we can write the equation like this,

$$P(x = 0, L) = \int_{0}^{L} |C|^2 dx = 1$$

In calculus the integration of this formula simply gives us,

$$C = \sqrt{1/L}$$

Solving this equation for half the length of the tube of dx = L/2

is,

$$P(x = 0, L/2) = \int_0^{L/2} |\sqrt{1/L}|^2 \, dx$$
$$= \left(\frac{1}{L}\right)\left(\frac{L}{2}\right)$$
$$= 1/2 \text{ or } 50\%$$

A Deeper Dive – Quantum Waves and Particles

Quantum states are incredibly more complicated than classical states and much more bizarre. For the purpose of illustration only, the wavefunction (ψ) describes the state of a quantum particle in a one-dimensional world. The wavefunction, ψ(x), actually describes a whole infinity of numbers at each location x. The graphs below show how the amplitude of a wavefunction (ψ) as a result of a point '*x*' in space in Figure 1.3 (a) correlates with a possible wavefunction just before the particle hits the detection screen. The five higher intensity bumps would correspond to five bright interference patterns in the center of the double-slit screen. The dark lines in the interference pattern correspond to the zero points of the wavefunction. Just as in classical wave physics the energy in the amplitude of the waveform is equal to the square of the wave amplitude. The probability density for finding the particle at any '*x*' in Figure 1.3 (b) is simply the absolute value of the wavefunction (ψ) shown in Figure 1.3 (a) squared. Figure 1.3 (b) shows the graph of the probability density for finding the particle at any '*x*'.

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However, the point ‘x’ is not an exact number as the actual value of ‘x’ is infinitesimal. Therefore, we must look for a region for finding ‘x’ and not an exact value. This means that we need to find *average values* for the probability density for finding a particle in a region. Calculus is made for solving this problem like so:

Average value for the probability density of finding a particle in a region $= \sum_{x=a}^{b} |\psi(x)|^2$.

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The formula for this was given by Max Born (1882-1970) and is called the ‘Born Rule’. But we do not need calculus to understand that the area between the regions ‘a’ and ‘b’ in Figure 1.4 gives us the probability density for finding the particle in that region.

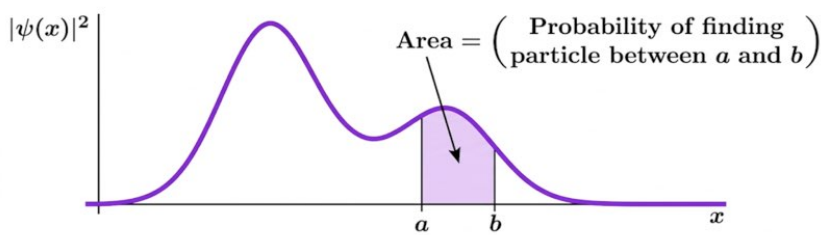

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Figure 1.4: The area under any interval of the graph of $|\psi(x)|^2$ is the probability of finding the particle within that interval.

There is one important condition to the Born Rule, the probability density for finding a particle somewhere in space must be 100%. This means it must be capable of satisfying the equation

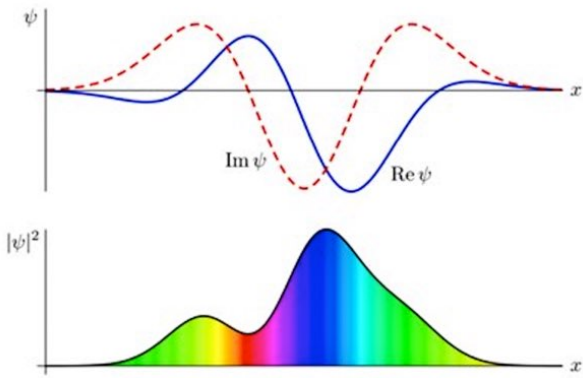
below,

$$1 = \sum_{x=-\infty}^{+\infty} |\psi(x)|^2$$

If this is true, then this wave function is said to be normalized. What does it mean to normalize a function? Normalizing allows us to compare apples to apples so to speak. Quantum computing works because its functions can be normalized. Because normalization gives us a common basis for making comparisons, we can have a certain amount of predictability and not purely random results. So, for example, when qubits are normalized their probabilities have more of a common relationship with each other so, combined as a group, their results mean something. Space itself can be a synchronicity that allows us to compare apples to apples. If a wave function were undefined or infinite it has no probability of being found somewhere in space. Therefore, it cannot be normalized.

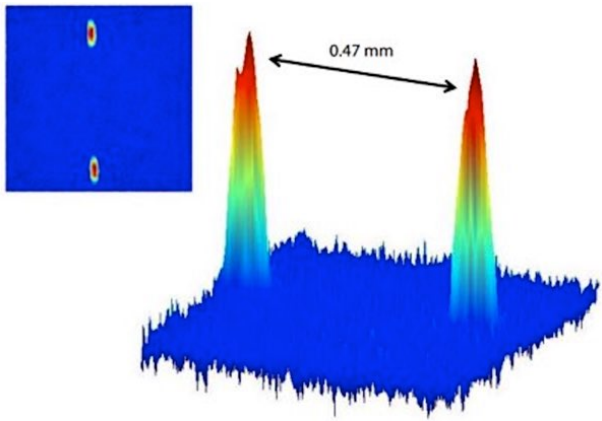
The wave function is a complex function meaning it has a real part and an imaginary part (to be discussed later). For now, just understand that the imaginary part is the square root of minus one which makes no real sense but so does quantum physics. In any case, if we square the square root of minus one, we simply get a real part equal to one. This is in essence why the probability density for finding a particle at any '*x*' has to be squared in a sense to 'make it real'. Effectively, this gives us a real value we can use to get the probability density for finding a particle in a certain region. In the upper part of Figure 1.10 you can see a graph depicting the real part and the imaginary part of this wave equation. The lower part of Figure 1.10 shows a graphic plot of the regions where the probability density for finding a particle might be found. The lighter colors like yellow indicate less probability density for where a particle might be found and the darker colors like dark blue

indicate more probability density where a particle might be found. This is called a phase diagram. A radian is another way to measure degrees. A radian is equal to π or 3.14159265. The conversion between radians and degrees is that one radian is equal to pi (π) so 180 degrees = π. The phase difference in the diagram below has the imaginary wave function a quarter cycle or -90 degrees or π/2 behind the real wave function.



The graph above is an arbitrary complex wavefunction that can be plotted either as separate real and imaginary parts (top) or as a probability density, filled underneath with color hues to indicate the complex phase (bottom). Sometimes a quantum particle is localized within a very small region of space. In this case the quantum wave function of Figure 1.3 (a) would not have nice undulating waves but one large spike perhaps going up starting and ending at zero. The mathematics for this situation can be very precise by taking the limit where the spike becomes infinitesimally narrow and infinitely tall. The de Broglie function will not work for this kind of spike. The function for this is called the 'Dirac delta function'. This would be called an eigenfunction of the eigenstate. We learned about the pure state or eigenstate earlier. *Eigen* in German simply means 'characteristic' or 'particular'. If there were

two spikes the delta function might look like the diagram below.



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The figure above shows a distribution of measured positions for a collection of about 10,000 identically prepared rubidium atoms, each with a wave function consisting of two narrow peaks, separated by about half a millimeter. It is sometimes called a 'cat state' in honor of Schrödinger's cat because it is not so easy to 'see' this for heavier particles meaning it may or may not exist but for massless photons it is easy to see. But the cat function can never happen in classical wave theory because this function is really telling us that a particle seems to be half in one location and half in another location *and* there is no meaning to the idea of halfway between two spikes. Remember in superposition 50% probability density for finding a particle to go through one of two slits? Another way to say this is if you measure the position of such a particle you are equally likely to find it near one or the other spike but not in between. Also, remember that this is simply a spooky guess but where the rubber meets the road in an actual experiment must always bump into the observer effect. The cat state can have more than two spikes with an even or an odd number of spikes. 228

This brings us back to an earlier discussion where we found that

energy is to time as momentum is to space (wavelength). Remember de Broglie's formula was,

P = h/λ where 'p' is momentum, 'h' is Planck's constant, and λ (lambda) is wavelength.

From the formula above we see that a longer wavelength will result in less momentum and a shorter wavelength will result in more momentum. So, the cat state will have a lot of momentum. Also, let's remember what we stated earlier concerning the exactness of location points for the probability density for finding an electron.

However, the point 'x' is not an exact number as the actual value of 'x' is infinitesimal. Therefore, we must look for a region for finding 'x' and not an exact value. This means that we need to find average values for the probability of finding a particle in a region.

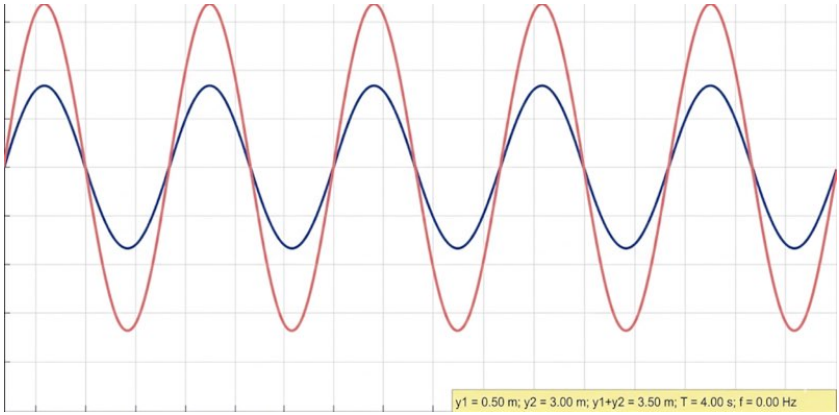
In the same way as position cannot be an exact value, no normalized momentum function can be perfectly defined either.

…no normalized wavefunction has a perfectly well-defined momentum; a perfectly well-defined momentum is an idealized but unphysical limiting case, just as perfectly well-defined position, described by a delta function, is an idealized limiting case. 229

Classic Waves and Quantum Waves

Here is the definition of a standing wave in classic physics.

In physics, a standing wave, also known as a stationary wave, is a wave that oscillates in time but whose peak amplitude profile does not move in space. The peak amplitude of the wave oscillations at any point in space is constant with respect to time, and the oscillations at different points throughout the wave are in phase. The locations at which the absolute value of the amplitude is minimum are called nodes, and the locations where the absolute value of the amplitude is maximum are called antinodes. 230



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Note: If the animation does not work click on the link in the footnote.

Classical standing waves and quantum wave interference patterns are both examples of wave phenomena that exhibit interference. In the case of standing waves, the interference is between two waves of the same frequency traveling in opposite directions, which results in a wave pattern that appears to be stationary. On the other hand, quantum wave interference patterns are formed when two or more waves of different frequencies interact with each other, resulting in a pattern of constructive and destructive interference. Interestingly enough, both standing waves and quantum wave interference patterns can be described mathematically using wave functions. In the case of standing waves, the wave function is a function of position that describes the amplitude of the wave at each point along the medium. In quantum mechanics, the wave function describes the probability density of a particle being in a particular state upon observation.

In quantum physics, a quantum state is a mathematical entity that embodies the knowledge of a quantum system. Quantum mechanics specifies the construction, evolution, and measurement of a quantum state. The result is a quantum mechanical prediction

for the system represented by the state. Knowledge of the quantum state and the quantum mechanical rules for the system's evolution in time, exhausts all that can be known about a quantum system. [232]

While there are similarities between these two phenomena, there are also important differences. For example, standing waves are a classical phenomenon that can be observed in many different types of waves, including sound waves and electromagnetic waves. Quantum wave interference patterns, on the other hand, are a purely quantum mechanical phenomenon that arises from the wave-particle duality of matter. While both standing waves and quantum wave interference patterns exhibit interference, they arise from different physical mechanisms and have different mathematical descriptions.

A Deeper Dive - The Mathematics of Quantum Physics

This can be very technical, so I want to give a general layout of the mathematics involved in more common uses of quantum physics. The first requirement needed to describe anything mathematically is a background, a canvas on which we can paint a foreground. The name of the most common background space is the mathematics of Hilbert space. Technically, a Hilbert space is a mathematical construct allowing us to generalize linear algebra and calculus to infinite-dimensional spaces. Various operators play a crucial role. More simply, it lays out a vector space in which particular places in the space can have different ‘foreground’ operations going on. Every point in Hilbert space can behave in certain ways given some assumptions set out by the theoretician or the experimental physicist.

An operator in quantum physics mathematics describes what might happen in specific regions or points in background Hilbert space. [233] One of the most common operators is the Hamilton operator. The Hamiltonian operator in quantum mechanics

corresponds to the total energy of a system. It encompasses both the kinetic energy and potential energy. The Hamiltonian operator, denoted as H, acts on a complex Hilbert space associated with the generator of a quantum system's dynamics.

Under most circumstances, this operator is assumed to be self-adjoint (an identity operator to be discussed further below). Identity operators can have a real spectrum meaning they are entire spaces which can have only real values (not imaginary values). This enables something very important in quantum physics called eigenstates which will be discussed later. The Hamiltonian operator is the sum of operators corresponding to the kinetic and potential energies of the system.

In one-particle systems, it is commonly expressed as: [H = T + V] where:

(T) is the kinetic energy operator (involving momentum and mass).

(V) is the potential energy operator (related to the system's interactions and potential energy).

The Schrödinger wave equation utilizes this form to describe systems described by a wave function. The expectation value of the Hamiltonian provides the total energy expectation value. It is always greater than or equal to the minimum potential energy of the system. For a normalized wavefunction, the expectation value of the total energy is given by the expectation value of kinetic energy plus the expectation value of potential energy. This ensures that the total energy is non-negative. Just to note, there can be other mathematics with negative energy values in certain rare situations. The Hamiltonian operator plays a fundamental role in quantum theory, connecting the system's energy spectrum to its time evolution. Its mathematical representation is crucial for understanding the behavior of quantum systems.

Hamiltonian mechanics is named after William Rowan Hamilton (1805-1865), who developed a revolutionary reformulation of classical Newtonian mechanics known as Hamiltonian mechanics.

This reformulation became historically significant for the development of quantum physics. In quantum mechanics, we represent the Hamiltonian as an operator. As mentioned, it corresponds to the total energy of that system, including both kinetic energy and potential energy. It combines the kinetic energy operator (T) and the potential energy operator (V). The spectrum of the Hamiltonian consists of the energy eigenvalues, which are the possible outcomes obtainable from measuring the system's total energy. Remember that eigenvalues are pure states of specific particles – how specific particles have been found to exist in various energy states. These eigenvalues play a crucial role in understanding the behavior and evolution of quantum systems. In its simplest form it looks like this,

$$\hat{H} \mid \psi\rangle = E \mid \psi\rangle$$

The hat (ˆ) on the 'H' means an operator in quantum physics. An operator is like a mathematical function which maps one state into another state. If I want to go from Alaska to Florida, it would be best to have a map to show you how you would go (at least in the old days). An operator performs different kinds of mathematical operations which take you from one state to another state. These states can be fields of space, time, position, momentum, kinetic energy, potential energy, total energy. The Hamilton operator addresses fields of momenta for various eigenstates. Each point in the field, a state, has a distinct momentum and direction. Therefore, the formula above relates the field (or wave function) of momenta to the field (or wave function) of total energy. Momenta (a point of momentum) is made up of magnitude and direction in vector form of various eigenstates of particles to total energy fields. So, if you know the total energy at a point in a field by measuring it you can relate that back to various particles in pure states. And vice versa if you know the eigenstates the various particles in a wave function you can calculate what the total energy at that point will be.

In Newtonian mechanics the position and momentum of an object determines its mechanical behavior. Think about this in terms of art. In art there is a foreground and a background. Newton's mechanics described mechanical motion in terms of the foreground, the object. Hamilton took the opposite approach. He reasoned that you could mechanically describe any object in the foreground by the background. If you understand the background, the field where objects play, you have more flexibility in describing what any old object would do mechanically in that background. You can also think of foreground/background as particle/wave. Now, you can see why quantum mechanics gravitated to Hamilton mechanics. The Hamilton of the quantum wave equation tells us how to relate to the total energy of the wave equation.

When the Hamiltonian operates on the wavefunction, it yields the Schrödinger equation, which describes the behavior of quantum systems. The Schrödinger equation is fundamental in understanding how particles evolve over time in quantum mechanics. It's fascinating to note that the Heisenberg representation, based on observables, is a powerful approach in quantum physics. In this representation, the canonical variables (position and momentum) are replaced by matrices, and the commutation rules are expressed through matrix algebra. This approach, developed by Heisenberg, Born, and Jordan, has become a cornerstone of quantum theory. The Hamiltonian acts on the wavefunction, guiding the behavior of quantum systems. [234]

There are many more operators than the Hamilton operator. Some of these other operators include:

- Projection Operators: These operators project vectors onto specific subspaces within the Hilbert space. For any closed subspace V, there exists a projection operator with a normalization of one. What? This means that we can describe how orthogonal geometric spaces transform and change continuously. By orthogonal I mean something

like our typical x, y, z coordinate system with each axis being 90 degrees from each other. However, these operators are not restricted to three dimensions.

- Linear Operators: A linear operator is a fundamental concept that allows us to perform transformations within an infinite-dimensional vector space. These are mappings from one vector to another within the Hilbert space. They can represent rotations, rescaling, permutations, and other transformations. Linear operators can also perform orthogonal operations. [235] In addition, linear operators can describe unitary functions. Unitary operations preserve the inner product with a normalization of one. Effectively, this means they deal well with complex vectors. Specifically, they can do complex valued rotations in Euclidean space. They can also do complex phase multiplication. This could be helpful in determining resultant spins of various 'waves' which can translate into particle spin upon observation. [236] Linear operators can also describe morphisms. Say what? An morphism is when the topology of something changes, the boundary conditions. Imagine changing a coffee cup into a sphere. Linear operators could describe and map these changes smoothly using complex variables. Ok, here is another oddball linear operator. It is called an anti-unitary operator. Think of playing a movie in reverse. Anti-unitary operators let us describe this reversal mathematically. I think you could see how this may be useful when it comes to time reversal. But here is the deal on that. There is nothing special about time from any other property like particle spin, charge, momentum, etc. The time operator whether forwards or backwards is not 'time itself'. Quantum physics does not have a physical description of what time could '*be*'. Just like spin, momentum, charge, etc. are a property mathematics can

describe, time is simply another property which can be described. It is really state change not time change. Going in reverse is theoretically, mathematically, describable but practically impossible. Another example of a linear operator is a self-adjoint operator called a Hermitian. The previous operators are called bound operators. Self-adjoint operators are unbound. A bound operator is finite, it has more specificity. Bound operators are well-behaved and continuous. Unbound operators are unruly. They do not have a normal finite boundedness. They may be very picky about certain spots in space. They can be abrupt and discontinuous. They can result in enormous data calculations.

- Compact Operators: These extend the concept of matrices acting on finite-dimensional vector spaces. In Hilbert space, compact operators are precisely the closure of finite-rank operators (those representable by finite-dimensional matrices) in the topology induced by the operator norm. Compact operators are linear operators which are necessarily bound subsets. They allow calculations of sets of variables or vectors. So, let's say one set was a coffee mug and the other was the saucer the mug was sitting on. If you threw them up in the compact operator would tell you how both the cup and saucer would operate in space until they hit the ground at least. When they hit the ground, you would move into the realm of messy self-adjoint unbound operators not to speak of the crumbled glass all over the floor. Hilbert-Schmidt operators are a class of bounded, linear operations. Remember our background, Hilbert space? Hilbert-Schmidt operators map Hilbert spaces to each other. Hilbert-Schmidt operators are finite and well-behaved. They have finite dimensional ranges. They can also be what is termed identity operators. An identity

> operator acts on background spaces in such a way that each vector is unchanged in the transitions between these background spaces. Hilbert–Schmidt Operators: These form a two-sided *-ideal in the Banach algebra of bounded operators on H. They also constitute a Hilbert space which is naturally isometrically isomorphic to the tensor product of Hilbert spaces. 237

Two Forms of the Quantum Wave Function

Now we can get to the quantum wave function of Schrödinger. The Schrödinger equation is a fundamental concept in quantum mechanics that describes the behavior of quantum systems. It comes in two main forms:

Time-Dependent Schrödinger Equation:

This form describes how the wave function evolves over time. It accounts for continuous evolution and deterministic behavior. This means we can derive probabilities for outcomes of superposition without having to measure each ingredient in the superposition which would by the observer effect alter the superposition into a classical state (collapse or branch of information) and make finding the outcome of the combined states or eigenstates impossible to recover. Since we cannot measure the superposition due to the observer effect a continuous evolution of the superposition wave function can give us a probability of how it evolves so we can have an idea of what we might see when we do measure. Schrödinger's original version was nonrelativistic meaning the times in the continuous evolution are not close to or equal to the speed of light. The general equation is indeed quite general, used throughout quantum mechanics, for everything from the Dirac equation to quantum field theory, by plugging in diverse expressions for the Hamiltonian.

However, here's the twist: While the Schrödinger equation itself is deterministic, the relationship between a system's wave function

and its observable properties appears to be probabilistic. While the Schrödinger equation itself is deterministic, it leads to probabilistic outcomes due to the observer effect upon measurement when the wave function collapses or branches. A more specific way to think about this is that the amplitudes of the probabilities are deterministic throughout the temporal changes while it is in superposition. There is a dance here between determinism which can never become 'real', ontological, or actual and the probabilistic which must always remain 'real', ontological, or actual. The collapse of epistemology into ontology is always dependent on the observer. The fissure between these two cannot be bridged by the history of metaphysics or dialectical reasoning in Hegel. There is no hierarchy of becoming into Concept. And Concept does not collapse into absolute negation of itself only to rise again in being and nothingness. This fissure is not traversable. In physics we call this spooky and in philosophy we must reckon ourselves to radical alterity which can only call us to responsibility for what can never evolve into my idea of the other, the observer.

To apply the Schrödinger equation, we write down the Hamiltonian for the system, accounting for the kinetic and potential energies of the particles (eigenstates or pure states of the particles) constituting the system in superposition, then insert it into the Schrödinger equation. The resulting partial differential equation is solved for the wave function, which gives us probabilistic information about how the states change over time in superposition so that once it is observed (measured) we have an idea of what to expect. In practice, the square of the absolute value of the wave function at each point is taken to define a probability density function.

Time-Independent Schrödinger Equation:

This form deals with stationary states and energy levels of a quantum system. This form applies when the Hamiltonian does not explicitly depend on time. It provides solutions for stationary states and energy eigenvalues. This form of the wave equation is

discontinuous and stochastic between measurements. The time-dependent Schrödinger equation predicts that wave functions can form standing waves, called stationary states or eigenstates. These states are particularly important as their individual study later simplifies the task of solving the time-dependent Schrödinger equation for any state. Stationary states can also be described by a simpler form of the Schrödinger equation, the time-independent Schrödinger equation. In this form the Hamilton operator is not dependent on time. This is like looking at snapshots at the beginning and end of a video. There is no continuous video to show us what happened between the snapshots. Additionally, time independence gives us a random probability distribution which can only result in statistical analysis. This brings us back to Schrödinger statistical interpretation of chaos as order-from-disorder.

Relativistic Considerations:

Here's where things get interesting: The standard Schrödinger equation isn't inherently relativistic, meaning it does not apply to speeds at or near the speed of light. However, physicist Paul Dirac (1902-1984) unified special relativity and quantum mechanics into a single framework. Paul Dirac, the eminent British theoretical physicist, made significant strides in bridging the gap between special relativity and quantum mechanics, two fundamental theories of physics. When relativistic effects are negligible, his formulation simplifies to the Schrödinger equation. Here is a brief history of how this remarkable unification was achieved (much of this will be discussed later):

1. **Relativistic Quantum Mechanics:**

    a. Relativistic quantum mechanics is a Poincaré covariant formulation of quantum mechanics that incorporates special relativity. Special relativity applies to how the speed of light changes space and

time to accommodate the speed of light. Special relativity has nothing to do with gravity and relative frames of reference as with general relativity. Relativistic quantum mechanics applies to massive particles moving at velocities up to those comparable to the speed of light. Relativistic quantum mechanics can also accommodate massless particles.

b. **Key features common to all** relativistic quantum mechanics **include:**

   i. Prediction of antimatter.
   ii. Determination of spin magnetic moments for elementary spin-1/2 fermions.
   iii. Explanation of fine structure.
   iv. Description of quantum dynamics for charged particles in electromagnetic fields.

c. The crowning achievement of relativistic quantum mechanics is the Dirac equation, which naturally emerges from the theory. This equation describes relativistic particles and their behavior, including electrons and quarks.

2. **The Dirac Equation:**

   a. In 1928, Paul Dirac formulated the Dirac equation, a relativistic wave equation that elegantly combines quantum theory with special relativity.
   b. The Dirac equation describes spin-1/2 massive particles (often called “Dirac particles”), such as electrons. It accounts for their behavior near the speed of light and predicts antimatter.
   c. Unlike non-relativistic quantum mechanics, where artificial terms (fudge factors) are introduced into the Hamiltonian operator to match experimental

observations, the Dirac equation naturally yields these predictions.

3. **Quantum Field Theory:**

    a. Dirac's work laid the groundwork for relativistic quantum field theory. In quantum field theory, elementary particles are interpreted as field quanta.
    b. A unique consequence of quantum field theory is the violation of conservation of particle number, as seen in matter creation and annihilation processes.
    c. Quantum field theory has been extensively tested and remains a cornerstone in modern particle physics.

Paul Dirac's ingenious contributions not only unified special relativity and quantum mechanics but also paved the way for our understanding of fundamental particles and their interactions. His legacy continues to shape theoretical physics today. For truly relativistic scenarios, we turn to other equations like the Klein-Gordon equation or the Dirac equation. In summary, while the time-evolution wave function represented by the Schrödinger equation is continuous and deterministic whereas the time-independent wave function changes discontinuously and stochastically during measurements.

Interpretations of the Quantum Wave Function

The quantum wave function is more like an unexplained phenomenon than what we associate with physics or math. It has a long history of physicists and philosophers not knowing what to make of it. It really is a one-of-a-kind oddball in human history. It is more like a Zen koan than almost anything else in Western history. The more you understand the quantum wave function, the more it

perplexes you. But don't feel alone, the greatest minds in human history have felt, written, debated, been dumbfounded about what the hell the quantum wave function 'is'…'is' does not escape all this either. If the quantum wave function does nothing else, it makes our easy distinctions between physics and philosophy obsolete. To begin to dwell on the quantum wave function means all the canned ideas we have of philosophy and physics need to go out the window. The road along this path is not comfortable because history does not afford us easy access. It is more like standing on the edge of a bottomless abyss than comfortably finding an ideological foothold in history and its commonsense product. There have been many interpretations of the wave function over the years.

An interpretation of quantum mechanics is an attempt to explain how the mathematical theory of quantum mechanics might correspond to experienced reality. Although quantum mechanics has held up to rigorous and extremely precise tests in an extraordinarily broad range of experiments, there exists a number of contending schools of thought over their interpretation. These views on interpretation differ on such fundamental questions as whether quantum mechanics is deterministic or stochastic, local or non-local, which elements of quantum mechanics can be considered real, and what the nature of measurement is, among other matters.

Despite nearly a century of debate and experiment, no consensus has been reached among physicists and philosophers of physics concerning which interpretation best "represents" reality. [239]

The table below shows many of the interpretations. The table is arranged by the dates these interpretations originated and their authors. Here is a brief description of the column headers:

- Determinism - Is the quantum wave function deterministic? Determinism is widely accepted in Western classical science and to some degree in classical philosophy and religion. It basically tells us everything is predetermined by intractable laws or processes. Or is the

quantum wave function indeterministic made up of irreversible processes?

Interpretation	Year published	Author(s)	Deterministic?
Ensemble interpretation	1926	Max Born	Agnostic
Copenhagen interpretation	1927	Niels Bohr, Werner Heisenberg	No
De Broglie–Bohm theory	1927–1952	Louis de Broglie, David Bohm	Yes
Quantum logic	1936	Garrett Birkhoff	Agnostic
Time-symmetric theories	1955	Satosi Watanabe	Yes
Many-worlds interpretation	1957	Hugh Everett	Yes
Consciousness causes collapse	1961–1993	Eugene Wigner, Henry Stapp	No
Many-minds interpretation	1970	H. Dieter Zeh	Yes
Consistent histories	1984	Robert B. Griffiths	No
Transactional interpretation	1986	John G. Cramer	No
Objective-collapse theories	1986–1989	Giancarlo Ghirardi, Alberto Rimini, Tullio Weber, Roger Penrose	No
Relational interpretation	1994	Carlo Rovelli	No[65]
QBism	2010	Christopher Fuchs, Rüdiger Schack	No

- Ontic Wave Function - Is the quantum wave function ontic or stochastic? Ontic means it actually alters ‘reality’ and stochastic means a random probability description. Is the wave function real? Are particles real? By random probability description we mean a guess or conjecture modeled as probabilities which has no necessary connection with what we think of as reality as it is purely abstract.

Interpretation	Year published	Author(s)	Ontic wave-function?
Ensemble interpretation	1926	Max Born	No
Copenhagen interpretation	1927	Niels Bohr, Werner Heisenberg	Some[60]
De Broglie–Bohm theory	1927–1952	Louis de Broglie, David Bohm	Yes[a]
Quantum logic	1936	Garrett Birkhoff	Agnostic
Time-symmetric theories	1955	Satosi Watanabe	No
Many-worlds interpretation	1957	Hugh Everett	Yes
Consciousness causes collapse	1961–1993	Eugene Wigner, Henry Stapp	Yes
Many-minds interpretation	1970	H. Dieter Zeh	Yes
Consistent histories	1984	Robert B. Griffiths	No
Transactional interpretation	1986	John G. Cramer	Yes
Objective-collapse theories	1986–1989	Giancarlo Ghirardi, Alberto Rimini, Tullio Weber, Roger Penrose	Yes
Relational interpretation	1994	Carlo Rovelli	No
QBism	2010	Christopher Fuchs, Rüdiger Schack	No[n]

- Unique History - Is the quantum wave function unique? Does it reflect a unique process? Is particle history unique

or does it reflect a multiplicity of histories? Is wave history unique or does it reflect a multiplicity of histories? Is the quantum wave function made up of coherent histories or limited in its applicability? If multiple histories, does comparing histories have any meaning? Is quantum theory merely a tool any agent may use to help manage their expectations? Does the past come into play only insofar as an agent's individual experiences and temperament influence their priors?

Interpretation	Year published	Author(s)	Unique history?
Ensemble interpretation	1926	Max Born	Yes
Copenhagen interpretation	1927	Niels Bohr, Werner Heisenberg	Yes
De Broglie–Bohm theory	1927–1952	Louis de Broglie, David Bohm	Yes[b]
Quantum logic	1936	Garrett Birkhoff	Yes[c]
Time-symmetric theories	1955	Satosi Watanabe	Yes
Many-worlds interpretation	1957	Hugh Everett	No
Consciousness causes collapse	1961–1993	Eugene Wigner, Henry Stapp	Yes
Many-minds interpretation	1970	H. Dieter Zeh	No
Consistent histories	1984	Robert B. Griffiths	No
Transactional interpretation	1986	John G. Cramer	Yes
Objective-collapse theories	1986–1989	Giancarlo Ghirardi, Alberto Rimini, Tullio Weber, Roger Penrose	Yes
Relational interpretation	1994	Carlo Rovelli	Agnostic[j]
QBism	2010	Christopher Fuchs, Rüdiger Schack	Agnostic[o]

- Hidden Variables - Is the quantum wave function made

up of hidden variables or undiscovered processes or is it something other than our common ideas of space and time, cause and effect?

Interpretation	Year published	Author(s)	Hidden variables?
Ensemble interpretation	1926	Max Born	Agnostic
Copenhagen interpretation	1927	Niels Bohr, Werner Heisenberg	No
De Broglie–Bohm theory	1927–1952	Louis de Broglie, David Bohm	Yes
Quantum logic	1936	Garrett Birkhoff	No
Time-symmetric theories	1955	Satosi Watanabe	Yes
Many-worlds interpretation	1957	Hugh Everett	No
Consciousness causes collapse	1961–1993	Eugene Wigner, Henry Stapp	No
Many-minds interpretation	1970	H. Dieter Zeh	No
Consistent histories	1984	Robert B. Griffiths	No
Transactional interpretation	1986	John G. Cramer	No
Objective-collapse theories	1986–1989	Giancarlo Ghirardi, Alberto Rimini, Tullio Weber, Roger Penrose	No
Relational interpretation	1994	Carlo Rovelli	No
QBism	2010	Christopher Fuchs, Rüdiger Schack	No

- Collapsing wave function - Does the quantum wave function collapse from superposition into a real effect perhaps occasionally affected by observation (the Copenhagen interpretation) or branches of simultaneous histories interpretation which are novel and emergent. In the branches of simultaneous histories interpretation, is collapse of the wave function a legitimate calculational procedure when describing the preparation of a quantum system or does it amount to nothing more than a convenient way of calculating conditional probabilities? Is the collapse of the wave function a negotiation process which implies a kind of retrocausality? Is collapse related only to observation or to spontaneous collapse without an observer? Does the wavefunction merely encode an agent's expectation for future experiences? Is the wave function merely a subjective probability distribution? Does a change in the wavefunction that an agent ascribes to a system as a result of having an experience represent a change in his or her beliefs about further experiences they may have?

Interpre-tation	Year pub-lished	Author(s)	Collapsing wave-functions?
Ensemble interpretation	1926	Max Born	No
Copenhagen interpretation	1927	Niels Bohr, Werner Heisenberg	Some[61]
De Broglie–Bohm theory	1927–1952	Louis de Broglie, David Bohm	Phenomen-ological
Quantum logic	1936	Garrett Birkhoff	No
Time-symmetric theories	1955	Satosi Watanabe	No
Many-worlds interpretation	1957	Hugh Everett	No
Consciousness causes collapse	1961–1993	Eugene Wigner, Henry Stapp	Yes
Many-minds interpretation	1970	H. Dieter Zeh	No
Consistent histories	1984	Robert B. Griffiths	No[f]
Transactional interpretation	1986	John G. Cramer	Yes[h]
Objective-collapse theories	1986–1989	Giancarlo Ghirardi, Alberto Rimini, Tullio Weber, Roger Penrose	Yes
Relational interpretation	1994	Carlo Rovelli	Yes[k]
QBism	2010	Christopher Fuchs, Rüdiger Schack	Yes[p]

- Observer Role - Is the quantum wave function a prediction of observation or measurement or both in

some way? Do observers separate the universal wave function into multiple sets of experiences? In the branches of simultaneous histories interpretation, are observers necessary to select a specific family of consistent histories (i.e., a framework), thus enabling the calculation of probabilities of physical events? Do observers play a purely passive role, similar to a photographer choosing a particular framing when taking a picture? Is the state of the system observer-dependent? Is the state of the system dependent on the specific reference frame of the observer? Are observers, or more properly, participants, essential to the formalism of the systems they interact with?

Interpretation	Year published	Author(s)	Observer role?
Ensemble interpretation	1926	Max Born	No
Copenhagen interpretation	1927	Niels Bohr, Werner Heisenberg	No[62][63]
De Broglie–Bohm theory	1927–1952	Louis de Broglie, David Bohm	No
Quantum logic	1936	Garrett Birkhoff	Interpretational[d]
Time-symmetric theories	1955	Satosi Watanabe	No
Many-worlds interpretation	1957	Hugh Everett	No
Consciousness causes collapse	1961–1993	Eugene Wigner, Henry Stapp	Causal
Many-minds interpretation	1970	H. Dieter Zeh	Interpretational[e]
Consistent histories	1984	Robert B. Griffiths	No[g]
Transactional interpretation	1986	John G. Cramer	No
Objective-collapse theories	1986–1989	Giancarlo Ghirardi, Alberto Rimini, Tullio Weber, Roger Penrose	No
Relational interpretation	1994	Carlo Rovelli	Intrinsic[f]
QBism	2010	Christopher Fuchs, Rüdiger Schack	Intrinsic[q]

- Local Dynamics - Is entanglement spatially local by

something such as local variables or non-local meaning not having any necessary regional relation to space as linear distance? If retrocausality is true, then would the transactional negotiation be non-local?

Interpretation	Year published	Author(s)	Local dynamics?
Ensemble interpretation	1926	Max Born	No
Copenhagen interpretation	1927	Niels Bohr, Werner Heisenberg	Yes
De Broglie–Bohm theory	1927–1952	Louis de Broglie, David Bohm	No
Quantum logic	1936	Garrett Birkhoff	Agnostic
Time-symmetric theories	1955	Satosi Watanabe	No[64]
Many-worlds interpretation	1957	Hugh Everett	Yes
Consciousness causes collapse	1961–1993	Eugene Wigner, Henry Stapp	No
Many-minds interpretation	1970	H. Dieter Zeh	Yes
Consistent histories	1984	Robert B. Griffiths	Yes
Transactional interpretation	1986	John G. Cramer	No[i]
Objective-collapse theories	1986–1989	Giancarlo Ghirardi, Alberto Rimini, Tullio Weber, Roger Penrose	No
Relational interpretation	1994	Carlo Rovelli	Possibly[m]
QBism	2010	Christopher Fuchs, Rüdiger Schack	Yes

- Counterfactually Defined - Do phenomena exist even

when they are not measured? Is this relevant for the entire universe or universes?

Interpre-tation	Year pub-lished	Author(s)	Counter-factually definite?
Ensemble interpretation	1926	Max Born	No
Copenhagen interpretation	1927	Niels Bohr, Werner Heisenberg	No
De Broglie–Bohm theory	1927–1952	Louis de Broglie, David Bohm	Yes
Quantum logic	1936	Garrett Birkhoff	No
Time-symmetric theories	1955	Satosi Watanabe	No
Many-worlds interpretation	1957	Hugh Everett	Ill-posed
Consciousness causes collapse	1961–1993	Eugene Wigner, Henry Stapp	No
Many-minds interpretation	1970	H. Dieter Zeh	Ill-posed
Consistent histories	1984	Robert B. Griffiths	No
Transactional interpretation	1986	John G. Cramer	Yes
Objective-collapse theories	1986–1989	Giancarlo Ghirardi, Alberto Rimini, Tullio Weber, Roger Penrose	No
Relational interpretation	1994	Carlo Rovelli	No
QBism	2010	Christopher Fuchs, Rüdiger Schack	No

- Extant Universal Wavefunction – Is the wavefunction an existent universal wavefunction or perhaps regional or situational?

Interpretation	Year published	Author(s)	Extant universal wave-function?
Ensemble interpretation	1926	Max Born	No
Copenhagen interpretation	1927	Niels Bohr, Werner Heisenberg	No
De Broglie–Bohm theory	1927–1952	Louis de Broglie, David Bohm	Yes
Quantum logic	1936	Garrett Birkhoff	No
Time-symmetric theories	1955	Satosi Watanabe	Yes
Many-worlds interpretation	1957	Hugh Everett	Yes
Consciousness causes collapse	1961–1993	Eugene Wigner, Henry Stapp	Yes
Many-minds interpretation	1970	H. Dieter Zeh	Yes
Consistent histories	1984	Robert B. Griffiths	Yes
Transactional interpretation	1986	John G. Cramer	No
Objective-collapse theories	1986–1989	Giancarlo Ghirardi, Alberto Rimini, Tullio Weber, Roger Penrose	No
Relational interpretation	1994	Carlo Rovelli	No
QBism	2010	Christopher Fuchs, Rüdiger Schack	No

As you can see there are many interpretations and difficulties understanding exactly what the wave function *is*. There are overlaps

in these categories so think of these categories as emphasis rather than exclusive. Also, many physicists and even I take mixtures of these interpretations.

While I am more inclined to Everett's interpretation, one important area I take exception to is that Everett's interpretation is deterministic. While it is uncertain whether Everett even believed this, determinism would depend on the many-worlds interpretation as literal. This is called strong determinism.

> A theory that specifies deterministic laws of both the Universe's temporal evolution and its exact initial condition satisfies what English physicist Roger Penrose called 'strong determinism' in his 1989 book The Emperor's New Mind. This is, according to Penrose, "not just a matter of the future being determined by the past; the entire history of the universe is fixed, according to some precise mathematical scheme, for all time". Let us say that a Universe is strongly deterministic if its basic laws of physics fix a unique cosmic history. If determinism provides a set of non-crossing train tracks, without specifying which one is being used, then strong determinism lays down a single track that has no choice even about where it starts…
>
> Schrödinger's equation), can satisfy strong determinism. However, in this case, the laws fix a cosmic history of a quantum Universe that has many evolving branches — a 'multiverse'… 249

Simply put, if all possibilities are literally happening in many universes simultaneously, then we can call that strong determinism. But this is not your mother's classical notion of determinism. If this is true, then the question of consciousness is what particular world is your consciousness aware of choosing? Ok, we could say that the other worlds are subconscious or unconscious. Perhaps we could also suggest that all the worlds have a dynamic overlapping quality

so then the conscious chooser would be a case of absolute free will at least for consciousness. In this case we wind up with both strong determinism and free will being true. This would be a contradiction but hey, quantum mechanics has no intrinsic problem with that.

No one believes that a literal interpretation of many-words is even possible to factually prove including Everett who did not use that term. Everett called his interpretation "relative-state formulation" which seems to me to echo Schrödinger's simultaneity of all alternatives. According to the Internet Encyclopedia of Philosophy, the Everettian Interpretation of Quantum Mechanics suggests that we abandon the notion of an observer-caused collapse and consider all quantum states to be always non-collapsed.

> In the 1950s, Hugh Everett III (1930-1982) was considering quantum mechanics as it might apply to the entirety of the universe. Surely if quantum mechanics were true on the local level of laboratories and experiments taken as closed systems, it would also be true for the entire universe taken as a closed system. The problem with this approach is that there is no external observer available at the scale of the entire universe to cause a collapse of the quantum state, a state that the laws of quantum mechanics say the universe would be in, were it unobserved. 250

For Everett, what was 'real' was all possible informational branches. As to the specific ontology, the word 'real', this is problematic in terms of Everett's relative state formulation. Everett is telling us all informational paths are relevant. In other words, there is not a hierarchy between all informational paths as one is real, ontological, and the others are idea, epistemological. He did not want to push these informational paths into those historic terms. The easiest way is to think of all the informational paths equally relevant and equally relational. I believe that maintaining Everett as deterministic in terms of historical designations of

ontology and epistemology would have to rest on a metaphysical postulate (e.g., literal belief in many worlds) and therefore cannot close out indeterminism emphatically. Additionally, we know that the quantum wave function in superposition has an infinite number of possible values. Does this mean there is an infinity of absolutely separate actual worlds? Not necessarily. Perhaps all these values are unique to a world or universe or overlap and are interwoven between the worlds or universes. It would probably even more ludicrous to think that nothing is real, and everything is ideal, epistemological, absolute Concept, etc. Pushing Everett into bipolar dualities of ontological or epistemological or mixtures of both shuts down the excess that I believe Everett is after in his relative state formulation.

One more point, if by 'determinism' you mean all informational possibilities are exhausted as branching where some information is lost to an observer, but all those lost informational paths are still valid and do not simply blink out into nonexistence or become virtual, epistemological, etc. then I would agree with the idea of determinism. For me, that is rather abstract but understandable. The branch of the observer is 'real' to the observer and subsequent information follows from the observer's specific branch. In this way branching is not deterministic but involves the concrete fact of observation and choice. No one was forced to look in the box to discover the fate of the cat. In physics, choice means what we choose to measure. Whether you think the wave function collapses or branches the observation or measurement actualizes upon each observation or information update. At each observation or branch a determinate path is taken until the next observation or update. This means at each juncture there is a novel or emergent path taken from an infinity of possibilities in superposition. Therefore, instead of determinism, there is at each juncture, observation or branch, a unique possibility for a truly novel and emergent history. More on Everett a little later.

The question of the wavefunction's 'isness', its ontology as, if

and how it exists in reality, and its status pertaining to its possibility, scope, and means toward relevant knowledge of the world and its epistemic validity, are all up for grabs. This table should give us a huge question mark about everything we think we know as the smartest people in world history are just as startled as us as to what this could possibly mean. I take this as a huge positive. If nothing else, it tells us that history, language, and culture, everything we think we know, has something to do with a radical alterity we have no clue about.

Schrödinger's Cat

Schrödinger's cat in the box obeys the determinations of the second proposal. As long as we do not look in the box everything proceeds along more or less according to Schrödinger's wave equation. In the case of the cat in the closed box, the time evolution of Schrödinger's wave equation and the cat is neither alive nor dead but in a state of superposition. Superposition can be thought of as all possibilities, but I prefer indeterminate because Schrödinger did not think the cat was alive or dead but a mixture of alive and dead. After all, if spontaneous broken symmetry is correct there are non-linear, abrupt, possibilities for random wave function collapse from indeterminate superposition to a determinate state. Schrödinger's quantum wave function is the embodiment of process two.

Over the decades of the 20th century, quantum entanglement has become as certain as physics can be that it is 'real' and that it equally and fundamentally questions what is 'real'. As one of the 20th century's most brilliant quantum physicists, Erwin Schrödinger famously called entanglement not "***one [property of quantum mechanics] but rather the characteristic trait of quantum mechanics, the one that enforces its entire departure from classical lines of thought***". [251] Entanglement, as "*the characteristic trait of quantum mechanics*" has passed the most rigorous standards of empirical proofs and can no longer be doubted. The odd thing

about entanglement is that it is so real in its empirical certainty that it has made our practical, historically based, assumptions about reality obsolete. As one of the greatest minds in human history, Einstein has called entanglement "spooky-action-at-a-distance". You may have heard about Schrödinger's famous 'cat in the box' thought experiment which denies any possible reality to the mortal life of a cat in a potentially deadly box until the box is opened and observed.[252] Why did Schrödinger write about quantum mechanics and cats in boxes? Because certainty about 'reality' is merely an illusion of our history. It is a narrative we merely assumed was true. Even more, the phenomenon of entanglement has fundamentally nothing to do with our certainties of space and time, our bedrock sense of 'reality'. The certainty of reality is not what *is* when we are not looking at it or thinking about it. It is only 'real' in our temporal observations of it. Distance and temporality have absolutely no effect on or relation with entanglement except in the act of experimental observation.

Schrödinger did not believe the wave function actually collapsed creating 'reality'. He thought that observation or measurement did not create a reality but showed us one branch of all alternatives, like the cat is alive and the cat is dead, but actually all the alternatives happen simultaneously.

> Although Schrödinger himself did not apply his idea to the famous cat, it neatly resolves that puzzle. Updating his terminology, there are two parallel universes, or worlds, in one of which the cat lives, and in one of which it dies. When the box is opened in one universe, a dead cat is revealed. In the other universe, there is a live cat. But there always were two worlds that had been identical to one another until the moment when the diabolical device determined the fate of the cat(s). There is no collapse of the wave function. Schrödinger anticipated the reaction of his colleagues in a talk he gave in Dublin, where he was then based, in 1952.

After stressing that when his eponymous equation seems to describe different possibilities (they are "not alternatives but all really happen simultaneously"), he said:

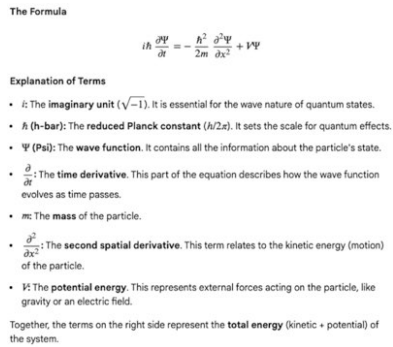
> Nearly every result [the quantum theorist] pronounces is about the probability of this or that or that … happening — with usually a great many alternatives. The idea that they may not be alternatives but all really happen simultaneously seems lunatic to him, just impossible. He thinks that if the laws of nature took this form for, let me say, a quarter of an hour, we should find our surroundings rapidly turning into a quagmire, or sort of a featureless jelly or plasma, all contours becoming blurred, we ourselves probably becoming jelly fish. It is strange that he should believe this. For I understand he grants that unobserved nature does behave this way—namely according to the wave equation. The aforesaid alternatives come into play only when we make an observation — which need, of course, not be a scientific observation. Still it would seem that, according to the quantum theorist, nature is prevented from rapid jellification only by our perceiving or observing it … it is a strange decision. 253

A Deeper Dive: The Mathematics of a Wave Equation

Below is a simple non-relativistic, time dependent Schrödinger wave equation. This equation assumes that symmetry is not broken. In other words, if we are not looking or observing a particle or particles, we can assume they have a symmetry based on probabilities of how they will function over time. If we were looking or observing with say an electromagnetic field, we would have to have another wave function which would characterize that range of time evolution.

By breaking symmetry or observation as mentioned above, we have introduced another discontinuous path which irreversibly changes a plethora of infinites. One way of expressing this plethora

is as a ‘universe’ of possibilities which branch off, not only the particular particles under observation, but irrevocably changing new branches from all other previous branches (i.e., the entire universe) causing a shattering, a diffusion, of universal branches. This is the ugly, rather embarrassing, and not career making, swept under the covers, historic predicament of quantum physics. So, the equation below is as if we did not look under the covers, break symmetry, somehow let one, unobserved branch continue on in time. This is the *time-dependent Schrödinger equation showing the relationship between the wave function, time, and space.*


The Formula
$$i\hbar\frac{\partial\Psi}{\partial t} = -\frac{\hbar^2}{2m}\frac{\partial^2\Psi}{\partial x^2} + V\Psi$$
Explanation of Terms
• i: The imaginary unit ($\sqrt{-1}$). It is essential for the wave nature of quantum states.
• $\hbar$ (h-bar): The reduced Planck constant ($h/2\pi$). It sets the scale for quantum effects.
• Ψ (Psi): The wave function. It contains all the information about the particle's state.
• $\frac{\partial}{\partial t}$: The time derivative. This part of the equation describes how the wave function evolves as time passes.
• m: The mass of the particle.
• $\frac{\partial^2}{\partial x^2}$: The second spatial derivative. This term relates to the kinetic energy (motion) of the particle.
• V: The potential energy. This represents external forces acting on the particle, like gravity or an electric field.
Together, the terms on the right side represent the total energy (kinetic + potential) of the system.

Explanation of Terms (without the special characters on the graphic above)

• *i*: is the imaginary unit. The square root of minus 1. It is essential for the wave nature of quantum states. • h-bar: The reduced Planck constant (*h/2pi)*. It sets the scale for quantum effects.

• psi: The wave function. It contains all the information about the particle's state.

• The time derivative: This part of the equation describes how the wave function evolves as time passes.

• *m*: The mass of the particle.

• The second spatial derivative: This term relates to the kinetic energy (motion) of the particle.

• *V*: The potential energy. This represents external forces acting

on the particle, like gravity or an electric field.

Together, the terms on the right side represent the total energy (kinetic + potential) of the system.

Ok, don't get thrown off by all the Greek and funny math. Here is a breakdown of what each part means:

The Time-Dependent Schrödinger Equation is written in not so simple terms as:

*i * h-bar * (partial derivative of psi with respect to t) = - (h-bar squared / 2m) * (second partial derivative of psi with respect to x squared) + V * psi*

Even worse than Greek - but what the heck does that mean?

Explanation of Terms (with further explanations):

The **left side of the equation**-First Term.

i times h-bar

• *i* - The imaginary unit (the square root of -1). The name "imaginary" makes them sound like they don't exist—like unicorns or dragons. In reality, they are just as "real" as any other number; they just live on a different **dimension**. It is essential for describing the wave-like nature of quantum states.

• h-bar - The reduced Planck constant is the Planck constant in cycles per second converted to radians which is more convenient for physics (h-bar = *h/2pi*). This constant sets the scale for all quantum mechanical effects.

• Note: This is an energy connection multiplier that transforms the time-derivative into an energy operator. In quantum mechanics, the way a system "ticks" over time is directly determined by its total energy.

$\partial\Psi/\partial t$

• ∂ (partial differential): A partial derivative can be thought of as a way of measuring how one specific factor affects a result while pretending everything else is frozen in time.

• Ψ (psi) is the symbol for the wave function. This mathematical function contains all the possible information about the state of a particle.

• Therefore, the partial of the wave function Ψ (psi) divided by partial ∂t or the partial time derivative. This part of the equation describes how the wave function changes and evolves as time passes. It represents how the wave function **changes** over time. It's like looking at a frame of a movie and using this term to calculate what the very next frame will look like. It tells us precisely how the quantum state is evolving at any given moment.All that is the left side of the equation. All of that…

$=$ (is equal to the **right side of the equation**.)

minus $\hbar$ (h-bar), the reduced Planck constant, squared divided by 2 times m (the mass of the particle).

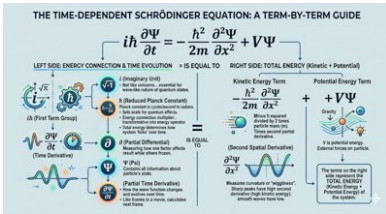
(all of minus $\hbar$ squared / 2 times m) **times**

• the second partial derivative of the wave function. It measures the **curvature** or "wiggliness" of the wave. A wave with sharp peaks has a high second derivative (high kinetic energy); a flat, smooth wave has a low second derivative (low kinetic energy) divided by the second order derivative.
• all of that is the **first term** and represents the kinetic energy or the energy of motion

plus the **second term**

• V is the potential energy. This represents external forces acting on the particle, such as gravity or an electric field.

Together, the terms on the right side of the equals sign represent the total energy (the sum of kinetic energy and potential energy) of the system. I created this chart to consolidate some of these ideas.


THE TIME-DEPENDENT SCHRÖDINGER EQUATION: A TERM-BY-TERM GUIDE
$i\hbar \frac{\partial \Psi}{\partial t} = -\frac{\hbar^2}{2m}\frac{\partial^2 \Psi}{\partial x^2} + V\Psi$
LEFT SIDE: ENERGY CONNECTION & TIME EVOLUTION
= IS EQUAL TO
RIGHT SIDE: TOTAL ENERGY (Kinetic + Potential)
i (Imaginary Unit)
ħ (Reduced Planck Constant)
∂/∂t (Partial Differential)
(Time Derivative)
Ψ (Psi)
(Partial Time Derivative)
Kinetic Energy Term
Potential Energy Term
(Second Spatial Derivative)
Measures curvature or "wiggliness".
Sharp curves have a large second derivative (high kinetic energy); smooth waves have low.
Gravity
V is potential energy. External forces on particle.
The terms on the right add up to the TOTAL ENERGY (Kinetic Energy + Potential Energy) of the system.

In more simple words, the time-dependent Schrödinger equation is the "master map" for the quantum world. Just as Newton's laws predict where a baseball will land, this equation predicts how a quantum system (like an electron) evolves over time. Instead of giving a single exact path, it describes a probability wave that spreads through space and changes as time passes.

More specifically, the **Time-Dependent Schrödinger Equation (TDSE)** is *analogous* to the quantum version of **Newton's Second Law (force equals mass times acceleration)**

While Newton's law predicts the exact path of a baseball, the TDSE predicts how the "**probability wave**" of how a subatomic particle changes over time.

1. It acts like a "Crystal Ball" for Waves

The equation tells you: *"If I know what the particle's wave function looks like right now, how will it look a few seconds from now?"*

Instead of tracking a single "point" (the particle), the equation tracks a "cloud" of possibilities. It calculates how that cloud spreads out, moves, or vibrates as time passes.

2. It Balances the Energy

The equation is essentially a balance sheet for energy. It says that the **Total Energy** of a particle is the sum of two things:

1 Kinetic Energy: How much the wave is curving and moving

(the second derivative term).

2 Potential Energy: The outside forces, like magnets or gravity, pushing on the particle.

3. It Explains Why Matter is Stable

Because the TDSE treats particles like waves, it explains why electrons in an atom don't just spiral into the nucleus. It forces the waves into specific "allowed" shapes (harmonics), much like a guitar string can only vibrate at certain notes.

A Simple Analogy: The Rippling Pond

Imagine you toss a stone into a pond:

• The **Wave Function** is the pattern of ripples on the water.

• The **TDSE** is the set of rules that tells the ripples how fast to move and how to bounce off the edges of the pond.

• **The "Last Term"** I discussed earlier acts like rocks or obstacles in the pond that the ripples have to flow around.

Summary: What it "Does"

• **Input:** The current state of a particle and the forces acting on it.

• **Output:** A map of where that particle is **likely to be** in the future.

The Schrödinger equation is not the only quantum mechanical way to make predictions over time. In Max Born's statistical interpretation of non-relativistic quantum mechanics the square modulus of the wave function is a real number interpreted as the probability density of measuring a particle at a given place.[255] Werner Heisenberg (1901-1976) introduces matrix mechanics which uses n-dimensional space functions to make predictions.[256] Richard Feynman (1918-1988) was the chief developer of path integral formulation.[257] In this formulation instead of a single trajectory path for a particle to follow, it computes an infinity of possible quantum mechanical trajectories to arrive at a quantum probability amplitude.[258]

The path integral formulation is a description in quantum

> mechanics that generalizes the action principle of classical mechanics. It replaces the classical notion of a single, unique classical trajectory for a system with a sum, or functional integral, over an infinity of quantum-mechanically possible trajectories to compute a quantum amplitude. 259

Because the path integral reproduces Schrödinger's wave function over all possible paths, an infinity of possible paths, it works well with superposition. It is referred to as a sum of possible histories. When observation of the wave function occurs, the probabilities of the initial and final amplitude are determined. This is why it also works well with quantum field theory to be discussed later. From the infinity of every possible path as a sum of possible histories we can get the idea of the branching of many possible worlds and observation collapse into a probabilistic outcome. Paul Dirac (1902-1984) combined matrix mechanics and the Schrödinger equation into a single formulation.

Collapse of the Quantum Wave Function and Entanglement

As previously discussed, we have the indeterminacy of Schrödinger's cat in the box. This indeterminacy is called superposition. Superposition can be thought of as the possibility of multiple, mixed eigenstates or idealizations of pure states. The wave function collapse in quantum mechanics occurs when a wave function, initially in a superposition of several eigenstates, reduces to a single eigenstate due to interaction with the external world. This interaction is often referred to as an observation, which connects the wave function with classical observables like position and momentum. It's one of the two processes by which quantum systems evolve in time—the other being the continuous evolution governed by the Schrödinger equation.

An eigenstate of a wave function is a complex number that may indicate position, momentum, probabilities, etc. of a particle with a

real and imaginary part which is always simply a multiple of some particular wave function. [260] When multiple measurements of an eigenstate are made using continuous variables over a range such as time, position, momentum, probabilities, etc. this is called a pure state. Any state in between these pure states is called mixed states. Experiments rarely produce pure states. [261] Pure states have no 'existence' in superposition except as possibilities or potentials. And, as mentioned, these states themselves are truncated versions pulled from point-like idealizations of infinities of transitions all occurring simultaneously on less truncated versions. For example, electrons are thought of as point-like particles but going on as 'electron' are virtual electron-positron (anti-electron) pairs, muons-anti-muons, quarks-antiquarks (all flavors and colors), a plethora of loops and virtual particles, "a whole universe of elementary particles", all pulled from vacuum energy (to be discussed later) or pulled into and out of existence 'to be' what we call an 'electron', and as 'being' they can be renormalized as a point-like particle.

In an ideal sense, when observation collapses a wave function, the superposition state of indeterminacy collapses into a single eigenstate. We see all the possibilities materialize into a single state, still dynamic as in the electron plethora above, but able to take on a single possibility depending on what we are looking for and how we are looking (i.e., as in wave or particle). In the real world we generally see a spread of several state possibilities. This not only applies to single particles but whole quantum systems. For lack of better word, the system takes on characteristics which enable prediction and probabilities. The nether worlds are pulled from hazy existence into a branching nether world which remains dynamically hazy but characteristically determinate in some spooky fashion. These systems are highly and dynamically entangled, endlessly cohering and decohering,

> The quantum principle of superposition implies that any combination of quantum states is also a legal state. This

> seems to be in conflict with everyday reality: States we encounter are localized. Classical objects can be either here or there, but never both here and there. Yet, the principle of superposition says that localization should be a rare exception and not a rule for quantum systems.
>
> Fragility of states is the second problem with quantum classical correspondence: Upon measurement, a general preexisting quantum state is erased – it collapses" into an eigenstate of the measured observable…
>
> When a quantum system gives up information, its own state becomes consistent with the information that was disseminated. "Collapse" in measurements is an extreme example, but any interaction that leads to a correlation can contribute to such re-preparation: Interactions that depend on a certain observable correlate it with the environment, so its eigenstates are singled out, and phase relations between such pointer states are lost.[262]

The paper cited above concerns a topic of very recent studies which have discovered some remarkable results. Quantum Darwinism is a new and exciting area of research which gives us some clues about how the classical world emerged from the quantum world.

Quantum Darwinism

Quantum Darwinism suggests that wavefunction collapse resulting in localism may be a rare exception and not the rule for quantum systems. This can be a complex topic, so I will try to simplify it as best I can. Natural selection in Darwinism tells us that some selections are favored over other selections based on adaptation criteria. Quantum Darwinism has a form of natural selection which tells us that the wavefunction in superposition need not collapse to take on a definite direction, a locality, a definite measurement.

Instead, the wave function may retain a kind of memory of the localization which quantum physicists call a scar. A scar is something more properly called a pointer in physics. In other words, there is a propensity accumulated before collapse in the wave function itself to choose certain alternatives over others. Perhaps one way to think about this is that when an observation is made upon wavefunction branching both the observer and the observed, the 'observer wave' and the 'observed wave' meaning all the wave functions composing the 'wave environment' of the observer merge as a novel wave pattern which is retained in the wave function. I have already discussed how the wavefunction is not temporal as if evolving through time. Instead, the wave function has already in simultaneity anticipated what we perceive as temporal collapse or branching of the wave function. In Quantum Darwinism that particular simultaneity is retained metaphorically like a scar which makes some choice more possible than others, some preference more preferred than others, upon localization or wavefunction branching. If this line of inquiry turns out to be correct it could be thought of analogously like natural selection in Darwinism. This is not determinism but perhaps more like Karma. This offers a stability which is not purely random as to how the classical world emerged from the quantum world as one enduring possibility. Perhaps this is why we do not wake up in a new world every day.

This is not an agent-like God independent of the observer which collapses the wave function and therefore, pulls a determinacy from indeterminacy. It is clearer and will result in less confusion to think of collapse as informational branching. Collapse seems to denote a singular moment when superposition takes on a 'real' value. This is far from what happens. First of all, there are many types of wave functions. Perhaps wave functions most often do not collapse into a value, but ranges of values are retained. 'Collapse' in a sense would always be partial unless you metaphysically take in the entire universe or universes, like LaPlace's demon, driving a kind of

determinism of all possible branches actualize, Everett's many worlds interpretation as deterministic. Perhaps 'collapse' is best thought of as updating information which incessantly branches into more preferred branches of updated information. Henceforth, instead of recounting this more complete notion every time I have used the term 'collapse' but with the caveat of this more complete understanding.

Additionally, if the many-worlds or as Schrödinger himself stated, "*not alternatives but all really happen simultaneously*" [263] is correct, why would our world, our branch, always deterministically choose survival of the fittest, the Darwin approved branch? Instead, we see accidents, aberrations, random chances which may not thrive over time or may find enhanced adaptability to faster changing environmental conditions. The observer is not a monarch of nature but a dance with nature. Emergence as a key characteristic of Darwinism, has no prior cause, as a summation or necrophiliac enchantment of inanimate 'matter', which can be explained from *a priori* categories of understanding or Platonic forms. As '*the characteristic trait of quantum mechanics*' entanglement is prior to spacetime emergence meaning prior to cause and effect. Rather than command of the fittest, we have spookiness – not yet tamed or tamable. [264]

The collapse of the quantum wave function is into a classical quantum mechanics state.[265] By classical quantum state I mean quantum mechanical classical states such as position or momentum of an 'idealized' particle derived from particle accelerators and indirect evidence. These states are multi-varied processes of infinites wherein we have identified patterns of collapse. The Standard Model of Elementary Particles which will be discussed later are encapsulations of these patterns. When quantum systems (which make up everything) decohere, in some odd way, they still adhere to Schrödinger's wave equation throughout the apparent collapse to mixtures of classical quantum mechanics states but decoherence does not in itself reduce a system to a single

eigenstate.

> Before collapsing, the wave function may be any square-integrable function, and is therefore associated with the probability density of a quantum mechanical–system. This function is expressible as a linear combination of the eigenstates of any observable. Observables represent classical dynamical variables, and when one is measured by a classical observer, the wave function is projected onto a random eigenstate of that observable. The observer simultaneously measures the classical value of that observable to be the eigenvalue of the final state.[266]

Depending on experimental conditions and preciseness of the measurement, these patterns we call classical quantum states can be set up as a linear combination of an eigen (German: 'proper', 'characteristic, or 'own') basis. In measurement or observation, we collapse this linear combination into a combination of eigenstates or single eigenstate depending on the preciseness of our measurement. As mentioned earlier, pure states are rare. This is because due to decoherence or the loss of entanglement particles are always in transition called mixed states. Since the pure states are rare all possibilities are in the mixed state before being 'observed' in the wave function where only in collapse or observation does one possibility get actualized.

> Quantum decoherence explains why a system interacting with an environment transitions from being a pure state, exhibiting superpositions, to a mixed state, an incoherent combination of classical alternatives. This transition is fundamentally reversible, as the combined state of system and environment is still pure, but for all practical purposes irreversible, as the environment is a very large and complex quantum system, and it is not feasible to reverse their

> interaction. Decoherence is thus very important for explaining the classical limit of quantum mechanics, but cannot explain wave function collapse, as all classical alternatives are still present in the mixed state, and wave function collapse selects only one of them.[267]

The key in this last quote is that quantum collapse is irreversible. The block universe of Einstein's spacetime was and is completely reversible. God as the alpha and omega, the beginning and end is absolutely determinate. God is Laplace's demon which I will discuss later. Classical physics before the 20th century and after the early Greeks only knew an absolute. Hegel's dialectics reaches its pinnacle in absolute Concept before returning to forgetting itself in order to be absolute – 'the all'. Concept only allows indeterminacy as, yet another concept taken into the service of completing Concept. The excess to Concept must always be taken up, yet again by Concept. This totality is absolute. However, as we have seen, in the spookiness of quantum physics any determination branches off not to return to the same starting place but to emergence, novelty, which finds no place, no locality, to which it can return. Novelty takes 'the all', Concept, the universe, along with it as a branch which never returns to itself. How does this play on the individual, the subject, which can never return to itself and yet brings itself, its universe, its branch into the novelty of its own destiny? This will be explored later.

Observation is Measurement

The "Stanford Encyclopedia of Philosophy" started out its section entitled "Quantum Mechanics" like this,

> Quantum mechanics is, at least at first glance and at least in part, a mathematical machine for predicting the behaviors of microscopic particles — or, at least, of the measuring

> instruments we use to explore those behaviors — and in that capacity, it is spectacularly successful: in terms of power and precision, head and shoulders above any theory we have ever had. Mathematically, the theory is well understood; we know what its parts are, how they are put together, and why, in the mechanical sense (i.e., in a sense that can be answered by describing the internal grinding of gear against gear), the whole thing performs the way it does, how the information that gets fed in at one end is converted into what comes out the other. The question of what kind of a world it describes, however, is controversial; there is very little agreement, among physicists and among philosophers, about what the world is like according to quantum mechanics. Minimally interpreted, the theory describes a set of facts about the way the microscopic world impinges on the macroscopic one, how it affects our measuring instruments, described in everyday language or the language of classical mechanics. Disagreement centers on the question of what a microscopic world, which affects our apparatuses in the prescribed manner, is, or even could be, like intrinsically; or how those apparatuses could themselves be built out of microscopic parts of the sort the theory describes.[268]

I include this because the topics to be discussed pose a monumental challenge to not only physics but also philosophy. In this book I want to provide a general survey of *physis* to give some contextuality to more important questions which not only strike at the root of classical science but also classical philosophy. In using the term classical philosophy, I include not only ancient Greek and Roman philosophy but also modernist philosophy inclusive of Enlightenment starting with Descartes and through 19th century philosophy even submerged in Existentialism which grew as a reaction to its predecessors. Starting with 20th century physics with Einstein and philosophy with Husserl as phenomenology, both

continued through post-relativity and post-modernism, grappling one way or another with the astonishing uncertainties in contemporaneous physics and philosophy. In this book I intend to try my best to bring focus into these spooky avenues which science and philosophy have raised and, more importantly, to try to show its relevance in plain old commonsense. I believe the real crisis in Western politics, culture wars, environmentalism, economics, religious beliefs arising from reactionary desperation have to be addressed on new terms which is a direct result of the irretrievable collapse of foundational Western history. I do not claim to have a good enough grasp on other strains of ancient cultures including the East, but I think it highly likely that some of these topics bear relevance to them. I simply do not feel like I am qualified to address how these topics overlap with those cultures but there are plenty of sympathetic and monumental academic publications in both physics and philosophy I have discovered from authors all over the world.

In 1926 Erwin Schrödinger formulated the wave equation. The wave equation accurately calculated energy levels of electrons in atoms. He won a Nobel Prize for it in 1933.[269] The wave equation shows how quantum mechanics evolves over time. Each moment of evolution is called a state. However, each actual measurement of a physical system only reveals one definite state. The problem is that each actual measurement determines the states of any future measurement. This is a recursive effect where every measurement feeds back into every future measurement. The result is that there is never any fixed, objective way to understand quantum phenomena. Every time we look at it, it looks back at us, so we can never see it as it '*is*'. Phenomena on a most basic level are entangled with themselves and us. This is called the measurement problem of quantum physics.[270]

Think about this, quantum mechanics is the fundamental building block of everything we have ever known. Yet, entanglement as "*the characteristic trait of quantum mechanics*" tells us there is no persisting 'reality' to the quantum world that can be

separated from observation. One important note here, the word ‘observation’ is not very popular with some physicists due to misconceptions that we are referring to some kind of purely subjective psychic interpretation. I will discuss this further later, but first, to start, the universe does not have a perfect vacuum.

The vacuum energy of the universe has energy. It is called zero-point energy. Zero-point energy is the lowest possible energy that a quantum mechanical system can have.[271] All molecules, atoms, and quantum particles vibrate and jitter incessantly and randomly. Even at absolute zero Kelvin this random vibration and jitter still occurs. This random vibration and energy are why we do not live in a classical physics world. This has been given as a reason why uncertainty and Heisenberg’s uncertainty principle forever prohibiting absolute certainty.

Vacuum energy can also cause instabilities from which vast changes in the universe can occur instantaneously like early inflation of the universe. These are called metastable states. Vacuum energy or zero-point energy can cause symmetry breaking, chaos, and emergence. In Susskind’s book “The Cosmic Landscape” he gives an example of a metastable state.

Susskind asks us to imagine an infinite shallow lake of supercooled water. As space expands it clones itself. It does not grow by stretching itself. It grows by incessantly replicating itself. In the same way that space clones itself, our shallow lake has feeder pipes at the bottom of the lake which can inject new supercooled water. As the new water fills the lake the boundaries of the lake increase on all sides. If boats were sitting on the lake, they would get further and further apart until they could no longer see each other (think of space expanding so far that at some point the outskirts of space itself would take longer than the speed of light to reach a boat in the middle and an event horizon of sorts would form). Because the lake is supercooled occasionally tiny ice crystals would form and perhaps become little ice islands (think of dark matter in our universe?). However, because the lake was cloning

itself and expanding, the chances are high that the ice islands, like the boats, would grow apart too quickly to combine with other ice islands. From a physics point of view the lake is building up potential energy. At some point, suppose a rare occurrence happens which causes a freak, improbable event to happen. A few ice islands combine to just the right size where immediately all that stored potential energy gets immediately converted to actual energy and in an instant the entire lake turns into a huge chunk of ice. This is analogically how cosmic inflation happened at the beginning of our universe. (Susskind, 2008, pp. 301-306)

The universe can be thought of as the lake in the previous analogy. The fabric of space is not empty but seething with elementary particles popping in and out of existence. However, the energy levels, like the ice crystals, are so small and last for such a short time that no violations of the conservation of energy are affected. These are unmeasurably low levels of potential energy we call zero-point energy. However, this feeder bed of space is like the ice islands in that when measurable quantities of energy or mass need an elementary particle to transform itself, it sucks it up from this vast energy pool. As I will discuss later, very macroscopic events like lightning are sucked up from this cosmic reservoir. Also, transistors and capacitors are able to cross barriers which they normally could not do and, like the ice islands, cause an avalanche of potential energy to cross the seeming insurmountable barrier.

Particles popping in and out of existence is a way of thinking about virtual particles. Virtual particles popping in and out of existence, means their zero-point energy, exists extremely briefly then poof — is non-existent. But don't think that zero-point energy has no effect in the macroscopic world. Zero-point energy has dramatic effects which will be discussed later. For now, just think of lightning. All this will be discussed later.

When an electron moves from its energy shell in an atom to a higher energy shell, it absorbs energy. It absorbs energy by absorbing a photon or releases energy by annihilating a photon all

from and back to zero-point energy. When an electron moves from its energy shell in an atom to a lower energy shell it emits energy. It emits energy by creating a photon. The photons actually pop in and out of existence by going down to zero-point energy or up from zero-point energy.

> Building on the work of Heisenberg and others Paul Dirac's theory of emission and absorption (1927) was the first application of the quantum theory of radiation. Dirac's work was seen as crucially important to the emerging field of quantum mechanics; it dealt directly with the process in which "particles" are actually created: spontaneous emission. Dirac described the quantization of the electromagnetic field as an ensemble of harmonic oscillators with the introduction of the concept of creation and annihilation operators of particles. The theory showed that spontaneous emission depends upon the zero-point energy fluctuations of the electromagnetic field in order to get started. In a process in which a photon is annihilated (absorbed), the photon can be thought of as making a transition into the vacuum state. Similarly, when a photon is created (emitted), it is occasionally useful to imagine that the photon has made a transition out of the vacuum state. In the words of Dirac:
>
> “The light-quantum has the peculiarity that it apparently ceases to exist when it is in one of its stationary states, namely, the zero state, in which its momentum and therefore also its energy, are zero. When a light-quantum is absorbed it can be considered to jump into this zero state, and when one is emitted it can be considered to jump from the zero state to one in which it is physically in evidence, so that it appears to have been created. Since there is no limit to the number of light-quanta that may be created in this way, we must suppose that there are an infinite number of light quanta in the zero state...” 272

So, vacuum energy can be thought of as a kind of grab bag. When elementary particles are needed or not needed, they are created or returned to the misty void from which they came, the zero-point vacuum energy. This includes entanglement and the very fabric of space which is thought to be highly entangled. The yawning gap supplies what is needed for 'reality' to exist…and it cares not if reality is 'stuff' or us. Even more, the abyss knows nothing of a 'me' which is separate from any other matter or entangled system in the universe. Our entangled system, our body… our thoughts provided by the incessant breakdown and rebuilding of neurons in our brain, affect other entangled quantum systems, which in turn affect us. This involves what the quantum wave function means as 'observation'. More on all that later.

In the statements that follow I am going to get into all these ideas in greater detail but for now just focus on how I am qualifying the role of the observer for this book. A human body which includes the brain is a massive quantum system made up of entangled particles cohering and decohering just like all other entangled systems as well as bound and unbound particles all imposed upon the background of the universe's vacuum energy. As such, entangled systems, including our body, are always affecting quantum energy and particles, including vacuum energy, around us. Explicitly, this means The observer—us, as another quantum system—plays a role in the quantum wave function. The point is that the observer is not some 'subject' isolated in a universe of objects as our historic common sense would have it. Not only do we affect phenomena but everything else does as well and everything else affects us as well.

At this point I would like to make a few important introductory comments which will apply throughout this book regarding the notions of 'observation' and 'collapse of the wave function'. For the sake of the Copenhagen interpretation which preferred collapse and Everett who prefers branching information, I will take both ideas to display an ambiguity which is left open and should be taken as not easily interpreted. There is an excess which I think is better left

with that emphasis. Personally, I lean towards Everett but I understand that that genie will probably never be put back in a bottle. With that being stated, there are some very interesting ramifications of ‘observation’ which have been debated in physics and philosophy which I would like to make a note of here. I hope all this will help make all this a little clearer. In this book, observation will specifically mean ‘registering decisions’.

> Of course the introduction of the observer must not be misunderstood to imply that some kind of subjective features are to be brought into the description of nature. The observer has, rather, only the function of registering decisions, i.e., processes in space and time, and it does not matter whether the observer is an apparatus or a human being; but the registration, i.e., the transition from the "possible" to the "actual," is absolutely necessary here and cannot be omitted from the interpretation of quantum theory.[273]

Subjective is a philosophy and extraneous to the current discussion. Accordingly, the idea of “registering decisions” in the quote above refers to enlarging information without trying to pin down this information anywhere between our cognizant recognition of the additional information to the experimental apparatus or ourselves used to acquire the information to everything else in the universe.

> Suffice it to say here that, in my view, the principle naturally supports and extends the Copenhagen interpretation of quantum mechanics. It is evident that one of the immediate consequences is that in physics we cannot talk about reality independent of what can be said about reality. Likewise it does not make sense to reduce the task of physics to just making subjective statements, because any statements about the physical world must ultimately be subject to experiment.

> Therefore, while in a classical worldview, reality is a primary concept prior to and independent of observation with all its properties, in the emerging view of quantum mechanics the notions of reality and of information are on an equal footing. One implies the other and neither one is sufficient to obtain a complete understanding of the world.[274]

The distinction here is that observation, updated information, participates in and has some added benefit of predictive behavior. However, there is also a sense in which the inability to specify information as complexity grows is equally important in my discussion. I will refer to the complexity of a-temporal/a-spatial information as the chaos or the yawning gap in deference to Hesiod. To be sure, classical physics also had chaos theory dependent on tiny variations in the initial knowledge of systems like weather conditions for example. Classical physics and philosophy understood that complete uncertainty was also a possibility. However, the difference in classical physics and quantum physics is the priority of the observer on the observed. Classical physics sought to find ways to minimize the role of the observer on the observed because it believed that there was an objectivity to physics which was irrelevant to the act of observation. Quantum physics takes as a given that the observer will not only have a substantial impact on the observed but is inextricably linked to the observation itself. Quantum physics has proven to the highest standards of physics that there is no 'objective' reality as classical physics believed. Objective reality is a historic fiction of history and language. Does this mean all is subjective – NO!

Objective and subjective are both fictions of history and language. There is an unaccounted-for excess, a spooky middle way between objective and subjective which is difficult to put into language because of our history which has not fashioned language to accommodate such an odd idea except perhaps in the largely lost idea of the middle voice. Language also affects physicists, but they

have an advantage in creating their own languages in mathematics which helps them overcome some of our linguistic obstacles. Even the language of mathematics in quantum physics has historic ambivalences. There are always competing theories which continually go through a rigorous winnowing process in which mathematical theories come and go. However, this intrinsic haziness is not some mere metaphysics of physicists. One reason we can point to a clear practical advantage from this chaotic process is due to the monumental changes to societies already being actively developed in quantum computing. More on that later.

Registering decisions updates information but notice that I have not assigned information to a homogeneous log of all information to which information can be synchronized. There are different ideas in the history of physics about the nature of information which are inseparable from philosophy that I will get into. For now, let's notice that this inability to synchronize all information, to find 'the truth', still retains a sense of chaos. Chaos as information which is not arranged or organized according to a scheme has been in physics for quite a long time. One example is called entropy - everything tends to disorder. I prefer the word chaos to entropy on the topic of information. There will be more discussion on this later as well.

For quantum physics' information falls out of the quantum wave function as registering decisions. Information and the quantum wave function are always incomplete as it can never mathematically be fully truncated to exclude iterative observations and the universe or more properly, what is called the 'many-worlds' branching aspect of information. I will discuss the 'many-worlds' idea later, but it is interesting to note that this idea arrives to us from the ancient Greek philosophers like Anaximander, Democritus, and Epicurus. Informational updates of the quantum wave function are a kind of truncation that produces more uncertainty but is necessary to arrive at predictable and useful conclusions. This truncation is what Bohr understood as the collapse of the wave

function. In this book the 'collapse of the wave function' is meant as an update of information which should not be understood as passive but as an active part and parcel of the continuing wave function. More about that later too.

Quantum physics cannot be absolute or deterministic because what we deem as commonsense, what simply '*is*' -> ***is*** probabilistic. There is no 'is' that is deterministic in quantum physics…more on all these 'is-esses' later. There are a number of schools of thought among physicists and philosophers of science on the topic of 'observation'. One objective or physical way to determine probability is called frequentism. In frequentism we simply observe the same phenomenon over a multitude of iterations and apply a probability number to it. If we flip a coin a large number of times, eventually we will see that there is a 50% chance of getting heads or tails. Given quantum probabilism is recursively dependent on observation and everything else, there are a number of different ways to define probability in quantum mechanics. The three leading ways are dynamic collapse [Copenhagen interpretation], pilot wave or hidden variable [de Broglie–Bohm interpretation], and many-worlds [Everett's many-worlds interpretation] theories which are interpretations of the quantum wave function.

Dynamic Collapse, Pilot Wave, and Many-Worlds Interpretations

> Let's consider three of the leading approaches to quantum theory. There are "dynamical collapse" theories, such as the GRW model proposed in 1985 by Giancarlo Ghirardi, Alberto Rimini and Tullio Weber. There are "pilot wave" or "hidden variable" approaches, most notably the de Broglie-Bohm theory, invented by David Bohm in 1952 based on earlier ideas from Louis de Broglie. And there is the "many worlds" formulation suggested by Hugh Everett in 1957.[275]

All of these interpretations have been debated by physicists and/or

philosophers alike from the 20th century until now. Let's take a brief look at all of them.

Dynamic collapse tells us there is fundamentally a random or chaotic component to the quantum evolution of the wave function. Rarely, on the smallest scales of quantum physics a wave collapse can occur spontaneously. But according to dynamic collapse theory, on larger scales, in our macroscopic world, collapses occur all the time. As we all know, cats are highly entangled creatures. When we actually look at the cat in Schrödinger's box, at least one particle will localize collapsing the wave function, and all the other particles in the cat will spontaneously collapse as well so the state of the cat becomes 'objective' for the person looking in the box. But if someone else walks in the room and they see the observer who knows the state of the cat, then they also will be elicited in the information update in a way that they were not before they walked into the room. My question is, if the cat is alive and has any idea of all this commotion – will he go back in the box and shut the lid again? There is a school of thought on dynamic collapse which thinks that gravity or spacetime curvature can spontaneously collapse the wave function without experimental observation. Wave function collapse is most notably associated with the Copenhagen interpretation of quantum physics.[276] Even in this school there are variations which assign more 'objectivity' to collapse and more interpretive 'subjectivity' to collapse. Personally, I see this as an inadvertent attempt to bring classical ideas of subjectivity and objectivity, especially modernist, into the haze where that language offers more problems than it solves.

Pilot-wave theory takes the objective world and determinism as real with one important exception. Pilot-waves harken back to the hidden variables of Einstein. Not only could Einstein not find them but according to later pilot-wave theory they are in principle unfindable. In 1814 Pierre-Simon Laplace published a paper which discussed a notorious hypothetical creature which had vast intelligence. The creature has subsequently been called Laplace's

demon. The demon knows absolutely everything past, present, and future about the universe. Therefore, it does not need the quantum wave function. However, for us, our only guide is the imperfect quantum wave function. The quantum wave function is only valid when we are making an observation. When we are making an observation, we are actually seeing what '*is*'. When we are not looking through the quantum wave function looking glass, there is no objective universe, there is no '*is*'. In fact, nothing can be known at all about hidden variables and the quantum world without our looking glass spectacles. We are condemned to ignorance and all we can do is cast a probability curve net over quantum reality. Therefore, in pilot-wave theory the universe is objective and, not to anyone's surprise, the quantum world is subjective. Pilot-wave theory preserves modernity's metaphysics of subject and object and the role of the mechanical senses with a bit of a demonic twist.

> Pilot-wave theories tell a very different story. Here, nothing is truly random; the quantum state evolves deterministically, just as the classical state did for Newton. The new element is the concept of hidden variables, such as the actual positions of particles, in addition to the traditional wave function. The particles are what we actually observe, while the wave function serves merely to guide them.
>
> In a sense, pilot-wave theories bring us back to the clockwork universe of classical mechanics, but with an important twist: When we're not making an observation, we don't, and can't, know the actual values of the hidden variables. We can prepare a wave function so that we know it exactly, but we only learn about the hidden variables by observing them. The best we can do is to admit our ignorance and introduce a probability distribution over their possible values.
>
> Probability in pilot-wave theories, in other words, is entirely subjective. It characterizes our knowledge, not an

> objective frequency of occurrences over time. A full-powered Laplace demon that knew both the wave function and all the hidden variables could predict the future exactly, but a hobbled version that only knew the wave function would still have to make probabilistic predictions.[277]

If there are hidden variables, then determinism can metaphysically be maintained. In 1957, Bryce DeWitt, editor of the journal Reviews of Modern Physics wrote:

> The Copenhagen Interpretation is hopelessly incomplete because of its a priori reliance on classical physics ... as well as a philosophic monstrosity with a "reality" concept for the macroscopic world and denial of the same for the microcosm.[278]

Then, along came Hugh Everett. The many-worlds theory of Hugh Everett is probably the most clear and direct explanation we can give Schrödinger's wave equation in a non-technical linguistic voice. First, don't get hung up right off the bat on the metaphysics of many-worlds or parallel worlds infinitely branching off each observation using the wave equation. That oversimple explanation in itself would only be pure metaphysical speculation. Everett himself did not call his theory many-worlds theory; he called it the "relative state formulation" of quantum mechanics. However, many-worlds theory has stuck so that is what I will use. Everett's many-worlds theory is based on informational updates which branch off upon observation using Schrödinger's wave equation. I like this explanation of Everett's many-worlds theory:

> According to the many worlds view, there is no difference between a particle or system before and after it has been observed, and no separate way of evolving. In fact, the observer himself is a quantum system, which interacts with

> other quantum systems, with different possible versions seeing the particle or object in different positions, for example. These different versions exist concurrently in different alternative or parallel universes. Thus, each time quantum systems interact with each other, the wave function does not collapse but actually splits into alternative versions of reality, all of which are equally real. [279]

Bell's Theorem proves that no theory based on Local Realism can reproduce the predictions of Quantum Mechanics, given some basic assumptions about the nature of measurement. It is named after physicist John Stewart Bell, who introduced the first derivation in a 1964 paper titled “On the Einstein Podolsky Rosen Paradox”. The theorem is broadly applied to a number of different derivations, all of which determine that quantum mechanics is incompatible with local hidden-variable theories, given some basic assumptions about the nature of measurement. The principle of locality, which refers to the idea that a particle can only be influenced by its immediate surroundings, and that interactions mediated by physical fields cannot propagate faster than the speed of light, is a key assumption in Bell’s theorem. Bell’s inequality can generate correlations that violate a Bell inequality because it violates an implicit assumption by Bell that measurements have a single outcome. In fact, Bell’s theorem can be proven in the Many-Worlds framework from the assumption that a measurement has a single outcome. Since this would constitute a violation of Bell’s inequality, it demonstrates that measurements must have multiple outcomes. The information in all the outcomes except the one that was actually measured cannot be said to not ‘exist’ unless we are willing to make a metaphysical statement that nothing exists. Many-worlds give us an ontological outcome that all the branches which include the ones that were lost, that were not measured, must actually exist in another world. Personally, I would rather think that what should be called into question is our idea of ‘existence’ itself. Both existence

and nonexistence are classical historic notions which, yet once again, make up a totality. The reduction to a totality denies an externality, an excess, which cannot be accounted for. Just as probability is endemic overturning ideas of certainty and its reductive negation of uncertainty in classicism, uncertainty has an excess which can never be made certain in whatever terms like existence, reality, absolute, etc. you want to resurrect from a bygone era.

Quantum Darwinism Again

Quantum Darwinism is a theory which builds upon the concept of decoherence theory. Decoherence occurs via the observer effect or perhaps, spontaneously interacting with the environmentally in highly unexpected ways. This interaction gets encoded and replicated into higher ordered classical structures. But rather than our observation forcing a quantum system into one state or another, quantum Darwinism suggests that the system's interactions with the environment can cause decoherence spontaneously. Decoherence is the process by which quantum superpositions (multiple states existing simultaneously) transition into definite classical states. In other words, the environment acts as a natural selector, favoring certain states over others. These favored states become the familiar, stable reality we perceive. Quantum Darwinism aims to address the quantum measurement problem—the paradoxical situations predicted by quantum theory (like Schrödinger's cat) that we don't encounter in our classical world.

Traditional quantum theory assumes a non-unitary transformation (decoherence) during measurement, but it doesn't explain the transition from superposed states to definite classical states. Quantum Darwinism posits those continuous interactions with the environment lead to the emergence of pointer states, bridging the quantum-classical gap. Quantum Darwinism aims to explain how classical behavior emerges from the underlying

quantum framework. Quantum Darwinism highlights the role of correlations in this emergence. The branching structure of the joint state of a system and its environment is crucial. This structure is compatible with zero quantum discord. What is zero quantum discord?

Quantum discord is a measure which quantifies the amount of discord between two subsystems of a quantum wave function system in superposition. What is meant by the amount of discord between 'two subsystems of a quantum wave function system in superposition' is a lack of correlations between the subsystems. Entanglement presents a certain amount of discord into the wave function which is equal to the entropy of entanglement. However, quantum discord also accounts for additional, more nuanced discord arising from certain quantum effects. These kinds of discord can even exist in certain mixed separable states, where entanglement is absent. Mathematically, quantum discord is defined in terms of the differences between shared quantum information between two subsystems of a quantum system in superposition. Another way to state this is that it is the difference between two expressions representing mutual information. These expressions involve entropy terms related to the subsystems' states. In the classical limit, these expressions yield identical results, but in the quantum case, they differ. The difference defines the basis-dependent quantum discord, which can vary depending on the chosen eigenbasis. Nonzero quantum discord indicates the presence of correlations due to the noncommutativity of quantum operators. It persists even when one subsystem undergoes infinite acceleration (as opposed to entanglement, which drops to zero under such conditions due to the Unruh effect). For pure states, quantum discord equals the entropy of entanglement. Vanishing quantum discord serves as a criterion for pointer states, which are effectively classical states of a system. These states play a crucial role in quantum measurement and decoherence processes. Zero quantum discord does not include entanglement. A bipartite quantum state

has zero quantum discord if and only if all blocks of its density matrix are normal matrices and commute with each other. Zero quantum discord corresponds to states where all correlations are purely classical, and quantum effects play no role.

For small, nonzero discord, the globally pure state closely resembles the branching form. These insights provide strong evidence that certain branching states are uniquely compatible with the emergence of classical behavior in our quantum universe. [280]

Copenhagen vs Everett

I want to give some perspective now as to how the two most dominant strains of wave function interpretations, the Copenhagen and Everett interpretations, are used and thought of by physicists. According to Susskind, who is a renowned and prominent physicist working in theoretical physics at Stanford, the Copenhagen interpretation requires a single external observer who is not part of the system. The observer can interact occasionally with the system in the process of measurement. In the Copenhagen interpretation the collapse is taken literally and throws away all the other branches which are not being observed or measured. This is the current practical working version of quantum physicists. However, this interpretation brings with it the downside of making reversibility too complex a process to ever be of practical importance.

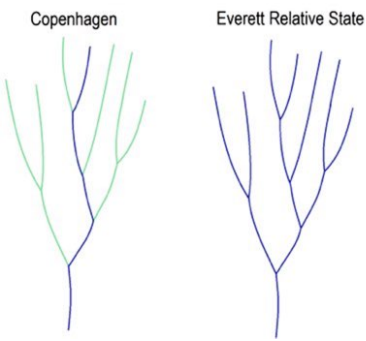
Susskind states that it is "*obvious that the Copenhagen interpretation cannot be the last word.*" Why is it obvious? Susskind tells us that it is obvious because the universe is much more intricate by being filled with subsystems in which any one of these systems can be in the role of the observer. He goes on to tell us that there is no place in the laws of quantum mechanics for the literal interpretation of wave function collapse. This is because the universe evolves unitarily and becomes increasingly complex.

> Standard quantum mechanics— Copenhagen quantum mechanics—is set up in a way that requires a single external observer, one who is not part of the system. He, she, or it interacts occasionally with the system through a process called measurement, and in so doing collapses the wave function, throwing away all branches other than the one observed. In this view observations are irreversible events which cannot be undone. The method works well in practice but only because reversing a measurement is generally too complex a process to ever be of practical importance.
>
> It is obvious that the Copenhagen Interpretation cannot be the last word. The universe is filled with subsystems, any one of which can play the role of observer. There is no place in the laws of quantum mechanics for wave function collapse; the only thing that happens is that the overall wave function evolves unitarily and becomes more and more entangled. The universe is an immensely complicated network of entangled subsystems, and only in some approximation can we single out a particular subsystem as THE OBSERVER. 281

To truncate the observer as solitary is to truncate the process for practical purposes. The way I read this is that perhaps we could think of this as analogously related to the practical uses of classical physics which is a limited case with accepted assumptions of relativity. In a similar way, reducing the observer to a more simplistic originator of wave function collapse makes current physics more useful in the short run. However, from what I have seen, just as classical physics 'practicality' threw up professional roadblocks to relativity by working physicists, the literal Copenhagen interpretation sets an academic standard which can also at some point perpetuate careers over further real progress in breakthroughs of known problems in quantum mechanics. Specifically, Susskind thinks that the roadblocks thrown up by the

standard interpretation create impediments to further progress in entanglement and quantum [282]gravity. Susskind and many other physicists believe that quantum gravity has and will move past these barriers. This has already been happening for many years now and incorporates entanglement in some really fascinating new ways which I will get more into later in this book. With this in mind I want to diagram the differences between the Copenhagen interpretation and Everett's interpretation.

In the Copenhagen diagram below, you can see that even though there 'are' other branches (in green), they are thrown away intentionally (in blue) to reduce and truncate the complications which come into play when the interaction of the other branches is considered.



[283]

Susskind tells us, "*Collapse of the wave function never takes place; instead interactions cause subsystems to become entangled*."

> The evolution of a quantum state is often described as a phase-coherent branching tree of possibilities. In the Copenhagen Interpretation the observer is considered to be outside the system but can interact with it from time to time by the process of measurement.
>
> Each measurement causes branches to decohere; the

quantum superposition being replaced by classical probabilities. The observer follows a trajectory through the tree. According to the Copenhagen Interpretation measurements are irreversible, and the relative phases between branches lose all meaning.

In practice this is the standard working interpretation of quantum mechanics, but it is not entirely consistent. Everett's Relative-State Formulation is an attempt to remedy the inconsistencies of the Copenhagen Interpretation.

According to Everett's Relative-State Formulation there is only one system, the universe; all observers are part of it, and are subject to the unitary laws of quantum mechanics. The system can be divided into subsystems any of which can be regarded as an observer. Collapse of the wave function never takes place; instead interactions cause subsystems to function, must be retained and the universe is the complicated network of entanglements that I referred to earlier.[284]

From this quote you can see how Everett's interpretation necessarily brings in quantum entanglement as "*the characteristic trait of quantum mechanics*" and is therefore more relevant in terms of information updating than wave function collapse and truncation. As we will see later many other issues such as an expansion of Einstein's Schwarzschild singularity or black hole into the very spookiness of entanglement itself, quantum bits or qubits, and unifying the very large and the very small in quantum gravity.

Everett's "relative state formulation" also called the 'many-worlds' interpretation is truer to Schrödinger's idea of entanglement as "*the characteristic trait of quantum mechanics*." Additionally, one piece of evidence that Everett was correct about the unsustainability of the Copenhagen interpretation is what quantum computing has been dealing with intimately, the way the environment makes the useability of qubits extremely difficult.

Quantum computing's isolation required for usability places heavy burdens on complexity theory, error correction, and higher energy states of entangled qubits which 'interfere' with useful applications. As I already quoted,

> According to the many worlds view, there is no difference between a particle or system before and after it has been observed, and no separate way of evolving. In fact, the observer himself is a quantum system, which interacts with other quantum systems, with different possible versions seeing the particle or object in different positions, for example. These different versions exist concurrently in different alternative or parallel universes. Thus, each time quantum systems interact with each other, the wave function does not collapse but actually splits into alternative versions of reality, all of which are equally real. [285]

Yet further,

> This view has the advantage of conserving all the information from wave functions so that each individual universe is completely deterministic, and the wave function can be evolved forwards and backwards. Under this interpretation, quantum mechanics is therefore NOT the underlying reason for the arrow of time.[286]

In Susskind's quote below he elaborates on this,

> Standard quantum mechanics— Copenhagen quantum mechanics—is set up in a way that requires a single external observer, one who is not part of the system. He, she, or it interacts occasionally with the system through a process called measurement, and in so doing collapses the wave function, throwing away all branches other than the one observed. In this view observations are irreversible events

which cannot be undone. The method works well in practice but only because reversing a measurement is generally too complex a process to ever be of practical importance.

It is obvious that the Copenhagen Interpretation cannot be the last word. The universe is filled with subsystems, any one of which can play the role of observer. There is no place in the laws of quantum mechanics for wave function collapse; the only thing that happens is that the overall wave function evolves unitarily and becomes more and more entangled. The universe is an immensely complicated network of entangled subsystems, and only in some approximation can we single out a particular subsystem as THE OBSERVER.

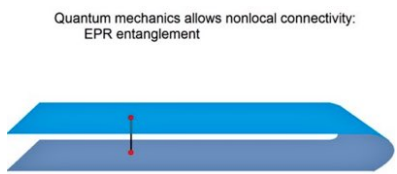
Until recently my view about these things was pretty similar to Feynman's with maybe a bit of Dirac's; namely: Quantum mechanics is so confusing that I can't even tell if there is a problem, but maybe it's all ok because it works. There is probably not much profit in thinking about "interpretations" and even less in arguing about them.

But over the last two years I've come to see it differently. Now I feel that our current views of quantum mechanics are provisional; it's the best we can do without a much deeper understanding of its connection with gravity, but it's not final. The reason involves a very particular development, the so called ER = EPR principle. ER = EPR tells us that the immensely complicated network of entangled subsystems that comprises the universe is also an immensely complicated (and technically complex) network of Einstein-Rosen bridges. To me it seems obvious that if ER = EPR is true it is a very big deal, and it must affect the foundations and interpretation of quantum mechanics. [287]

Here is Susskind's description of Einstein's Einstein-Rosen bridge

(ERB) which later became known as a wormhole between two blackholes.

> The two red dots are maximally entangled particles and I indicate their entanglement by linking them by a short black line. The black link has some structure; for example it distinguishes between the various maximally entangled Bell states. Despite appearances the nonlocal features of entanglement cannot be used to transmit messages superluminally (faster than light).
>
> General Relativity also has its non-local features. In particular there are solutions to Einstein's equations in which a pair of arbitrarily distant black holes are connected by a wormhole or Einstein-Rosen bridge (ERB). 288



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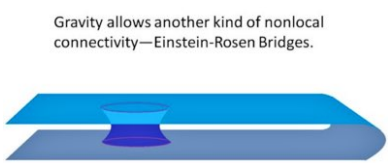

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Susskind dismisses the idea of teleportation of any form of matter through a wormhole. But he does believe through quantum entanglement information can be 'teleported' through a wormhole. We already have one amazing example of that – the singularity of the Big Bang in cosmology.

At first sight it would seem that ERBs can be used to superluminally transmit signals. But this is not so; the wormhole solutions of general relativity are "non-traversable. (Non-traversibility means that two observers just outside the black holes cannot communicate through the ERB. Non-traversibility does allow them to jump in and meet in the ERB.)

The similarity between figures 2 and 3 is quite intentional. The punchline of the ER = EPR joke is that in some sense the phenomena of Einstein-Rosen bridges and Einstein-Podolsky-Rosen entanglement are really the same [1]:

ER = EPR.

This is a remarkable claim whose impact has yet to be appreciated. There are two views of what it means, one modest and one more ambitious. The ambitious view is that some future conception of quantum geometry will even allow us to think of two entangled spins— a Bell pair—as being connected by a Planckian wormhole. For most of this lecture the more modest definition will suffice, but toward the end I'll speculate about the ambitious view.

The modest view first of all says that black holes connected by ERBs are entangled and also the converse; entangled black holes are connected by ERBs. But there is more to it than that. The idea can be stated in terms of entanglement being a "fungible resource." Entanglement is a resource because it is useful for carrying out certain communication tasks such as teleportation. It is fungible because like energy, which comes in different forms—electrical, mechanical, chemical, etc.—entanglement also comes in many forms which can be transformed into one another. Some forms of entanglement:

1. Ground state or vacuum entanglement.
2. Entangled particles.

3. Einstein-Rosen bridges.

4. See last part of this three-part lecture.

What about the conservation of the resource? Energy is conserved but entanglement is not, except under special circumstances. If two systems are distantly separated so that they can't interact, then the entanglement between them is conserved under independent local unitary transformations. Thus if Alice and Bob, who are far from one another, are each in control of two halves of an entangled system, the unitary manipulations they do on their own shares cannot change the entanglement entropy.

If Alice's system interacts with a nearby environment, the entanglement with Bob's system can be transferred to the environment, but as long as the environment stays on Alice's side and does not interact with Bob's system the entanglement will be conserved. 291

In the Copenhagen interpretation of the quantum wave function, the observer is an 'uber-observer', a superman observer. The uber-observer is the sole determiner of what happens upon observation of the wave function. Nietzsche's Übermensch (over man or superman) would have loved this. I would also add Ayn Rand to Nietzsche's club of admirers. However, throwing away all the other branches in favor of the 'actualized' classical branch does not reflect the entire wave function. It basically tells us to invalidate all the other probable outcomes of the observer effect upon superposition. Why? It seems to me because it relies on the classicism of 'reality' as determinate. Yet, we know that superposition cannot be thought in terms of 'reality' or ontology and has immense problems with epistemology which historically traces the many twists and turns of 'truth' and truth claims. Superposition does not fit comfortably in either of these historic determinations. It seems to me that Susskind may have some affinity for the odd kind of determinism which some believe is at the heart of Everett's relative state formulation

(many-worlds). Yet, in other works of Susskind he certainly demonstrates an amazing knowledge of informational complexity, emergence, and novelty so I would not be so quick to label him as purely deterministic in his interpretation of the quantum wave function. He is a very complex thinker. However, since I just mentioned emergence, I would like to bring up a point which will be investigated in more detail later. Emergence involves three ideas: symmetry breaking, randomness, and accident. Emergence plays a key role in biology, evolution, and life. Also, recall that in Heraclitus we saw randomness played a key role and in Aristotle accident plays a key role. Symmetry breaking can also be traced back to literary critiques that have analyzed how Frankenstein's monster breaks the classical symmetry and beauty of life. The monster is a unique creation that defies the natural order of life and death. It is a patchwork of different body parts, brought to life by the power of science and electricity. The monster's appearance is grotesque and unsettling, which further emphasizes its unnaturalness. The nether world disorder summoned up by the villainous, Victor Frankenstein who calls his creation various names like "creature", "fiend", "spectre", "the dæmon", "wretch", "devil", "thing", "being", and "ogre". The play of classical symmetry and its monstrous underbelly of disorder brings to the fore the ensnarement of binary dualistic totalities of order and disorder which can only miss completely the excess of which I have referred to as chaos. [292]

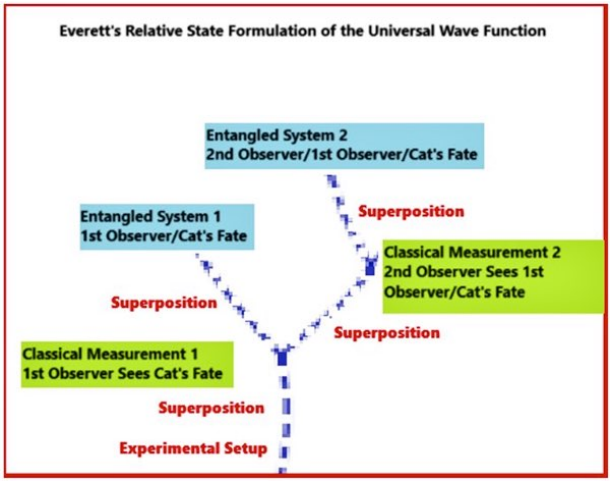
This notion of one wormhole between two blackholes or one tiny wormhole between two entangled particles relies more on the Copenhagen interpretation of the wave function. Susskind notes, "*In the Copenhagen Interpretation the observation irreversibly collapses the entangled state to a single unentangled product state.*"[293] This is too simplistic. This kind of Copenhagen interpretation based on informational dualisms of collapsing wave functions is not believed to be accurate by a dominant strain of physicists these days. Let's remember that Schrödinger's time evolution operator is deterministic, unitary, and continuous. This will be discussed in

much more detail later but for now I want to reiterate a few ideas about what this means. The time evolution operator is strictly for superposition. There is a predictability in superposition for highly controlled and *isolated* environments where chaining wave functions together or introducing other wave/particle which are also in superposition (as a wave) gives us highly predictable, determinate, and continuous results ***only while in superposition*** about probable density results upon observation (branching/collapse, pick your poison). Once observation is made the predictable, determinate, and continuous results while in superposition is lost forever, time evolution operations have ceased in classical state reduction and somehow resurrecting it like breathing life back into Victor Frankenstein's creation is impossible. The time evolution operator works beautifully going forward in time all the while in superposition. However, branching/collapse does not affect the 'universal wave function' at all as it has in some mysterious Laplace's demon sort of way already accounted for all the branching which occurred upon observation. And going backwards from a classical state to the 'original' superposition state would be a 'metaphysics' after classic reduction. As we will see in more detail later, going backwards in time while in superposition is an assumption called unitarity and Schrödinger's wave function but practically due to immense complexities impossible. In contradistinction to the Copenhagen idea of wave function collapse, Schrödinger and Everett's idea of branching is beautifully exhibited in Schrödinger's cat. I will use a simplistic example to give a better idea of how this works.

In the diagram below, the blue trace of a line is only a part of the universal wave function. The green background text shows the classical branch which occurs in the observer effect. The blue background text shows the continuation of superposition, the branch of the quantum wave function which was observed. A few things to note about the diagram:

The blue trace has the illusion of a timeline. It should not be

taken that way. As an analogy, the universal wave function is a very odd kind of absolute ‘now’ but it is really a-temporal. The universal wave function exceeds spacetime as entanglement exceeds and also is prior to spacetime. Spacetime emerges from the universal wave function due to the observer effect, the fall into classicism. One example of this is given by cosmology’s Big Bang singularity. But keep in mind that cosmology’s Big Bang singularity is not just something that happened at the beginning, an origin. In an odd way the universal way function is still ‘happening’ analogously as a universal ‘now’ moment. Also, the blue trace shows a separate branch moving away from the main branch to the 2nd observer. This is merely a pictorial necessity to have room for the text boxes. The 2nd observer does not branch until the observation is made. The main idea is that every observer effect branches off into its own spooky excess of the binary dualism of subject/object, self/other, mind/substance, etc. all captured by me/other’s narrative of classicism. Typically, we think in terms of me/other as a choice between poles of either narcissism or ethics. Additionally, the classical branches shown in the diagram are only one branch of an infinity of other possible branches (many-worlds) which cannot obviously be shown in the diagram. However, the Copenhagen interpretation is more like the diagram in that all the other branches are effectively thrown away. With all that in mind, here is how this diagram works:



The entangled superposition state entitled, "Classical Measurement 1 – 1st Observer Sees Cat's Fate":

a. What Schrödinger tells us is that in her act of classical observation she, the 1st observer,

   i. She branched into a classical information state on the entangled superposition system of the fate of the cat. This is the information branch update in the fate of her and the cat which has departed into classical observation.
   ii. But from the perspective of the universal wave function this entangled branch in which she knows the fate of the cat "Entangled System 1 – 1st Observer/Cat's Fate" continues on in superposition of her and the cat's universal wave function without ever seeing the classical state. It is as if there was no time or space but in some very odd way the wave function, for lack of better words, simply already knew about it.

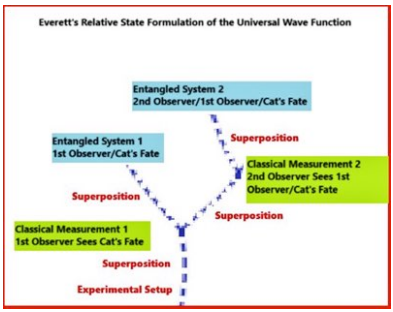
2. In the diagram below, the entangled superposition state entitled, “Classical Measurement 2/1st Observer/Cat’s Fate”:

    a. When the 2nd observer observes the entangled state of the entangled superposition state of the “1st observer and fate of the cat”,

        i. He branched into a classical information state on the entangled superposition system of the first observer/fate of the cat. This is the information branch update in the fate of him and the 1st observer/cat’s fate which has departed into classical observation.
        ii. But from the perspective of the universal wave function this entangled branch in which he knows the 1st observer/fate of the cat, he continues on in superposition of her and the cat’s universal wave function without ever seeing her classical state. It is as if there was no time or space but in some very odd way the wave function, for lack of better words, simply already knew about it. 295

One important caveat to this is that the new observer knows nothing about the entanglement of the first observer and her entanglement with the cat’s fate. The first observer and her entanglement with the cat’s fate now behave as one entangled system so all that information has been lost to classical observation. However, the Laplace-demon universal wave function still has that information in the universal wave function but going backwards in the wave function is practically impossible since that information, by virtue of wave function branching into classicism, is eternally lost to us or less dramatically, in the wave function branched into other ‘worlds’ unavailable to us. The idea of throwing away all the branches lost to classicism is why the Copenhagen interpretation is

flawed in the views of a number of physicists these days. The diagram again:



The first observer who initially observed the fate of the cat in the box continues on her own first informational entangled system branch with no entanglement or informational relationship with the new observer's entangled informational branch. Effectively, importantly, and highly un-classically, there never is an 'original' informational branch. There is no physical or even metaphysical connection between the informational branch of the first observer and the fate of the cat on the new observer's informational branch. Each informational branch has split off forever never to return. There is no reversibility in quantum physics' branching into classicism as there is in relativity. There is no copy, trace, original, or deletion of these informational branches. In a nutshell this is why the notion of an 'original' branch as in the Copenhagen interpretation is wrong. From the new observer's perspective, the first observer's informational branch as their 'own' would only mimic, **echo**, the metaphysics of history not *phusis*. Metaphysics has played itself out in history as totalizing tales we tell ourselves. However, as we will see in Levinas, there may be a thread, an intuition, such as we saw in Heraclitus, which intuited an idea it had no 'real' possibility for actualizing.

The conservation of information is of vital interest to physicists. Susskind's battle with Hawking concerning information falling into a blackhole and being lost forever according to Hawking motivated

Susskind and others to disprove it to their satisfaction and Hawking's satisfaction. Susskind writes,

> The problem was that Hawking's conclusion violated one of the central tenets of physics. Hawking of course knew that. It was why he found the idea of information loss in blackhole evaporation so exciting. But 't Hooft and I felt that the conservation of information was just too deeply built into the basic logical foundations of physics to discard it, even in the presence of such a bizarre object as a blackhole. If we were right then somehow the bits of information that fall to the horizon of a blackhole are radiated back out with the Hawking radiation, thus opening the way for imprisoned information to be signaled to the outside. 296

Quantum physics cannot relieve itself of the fundamental way observation changes 'reality'. We have to resign ourselves to accepting that 'reality' is not real in the way we want it to be, in the way history and language want it to be – so give it up. The best we can do is accept that information obtained from observation fundamentally changes what '*is*' on a case-by-case basis; meaning that information updates are not purely passive accumulations of information.

> Everett's radical new idea was to ask, What if the continuous evolution of a wave function is not interrupted by acts of measurement? What if the Schrödinger equation always applies and applies to everything—objects and observers alike? What if no elements of superpositions are ever banished from reality? What would such a world appear like to us?
>
> Everett saw that under those assumptions, the wave function of an observer would, in effect, bifurcate at each interaction of the observer with a superposed object. The

> universal wave function would contain branches for every alternative making up the object's superposition. Each branch has its own copy of the observer, a copy that perceived one of those alternatives as the outcome. According to a fundamental mathematical property of the Schrödinger equation, once formed, the branches do not influence one another. Thus, each branch embarks on a different future, independently of the others.[297]

What is History and Memory in the Quantum Wave Function?

When a quantum system is in a superposition of several eigenstates (multiple possible states), it can evolve according to the Schrödinger equation, which describes continuous evolution over time. However, when the system interacts with the external world (through observation or measurement), the wave function collapses. This collapse reduces the superposition to a single eigenstate. The essence of measurement in quantum mechanics lies in this interaction, connecting the wave function to classical observables like position and momentum. Before collapsing, the wave function can be any square-integrable function, associated with the probability density of the quantum system. It can be expressed as a linear combination of eigenstates of any observable (e.g., position, energy, spin). When an observable is measured by a classical observer, the wave function is projected onto a random eigenstate of that observable. Simultaneously, the observer obtains the classical value (eigenvalue) corresponding to the final state. Quantum decoherence shows that when a quantum system interacts with the environment, superpositions appear to reduce to mixtures of classical alternatives. Importantly, the combined wave function of the system and environment continues to obey the Schrödinger equation during this apparent collapse. However, decoherence alone does not fully explain actual wave function collapse, as it doesn't reduce it to a single eigenstate. Werner Heisenberg was the

first to propose wave function reduction to explain quantum measurement. Despite its mysterious nature, wave function collapse remains a fundamental aspect of quantum mechanics. The wave function maintains its histories until an observation occurs, triggering the collapse into a definite state. The mystery lies in the transition from superposition to a single outcome, defying classical intuition.

So, the question remains how would a subsequent observation be affected by a previous observation?

When an observation is made, the wave function representing a quantum system collapses into one of its possible states. However, the question of whether the previous observational history is maintained after subsequent collapses is intriguing. Imagine we observe a quantum system, and its wave function collapses to a specific state (let's call it State A). At this point, our knowledge of the system is updated based on this observation. If we perform another observation on the same system, the wave function collapses again. However, the outcome of this second collapse depends on the initial state (State A) and the measurement we make. It could collapse to a different state (State B), or it might remain in State A. Here's where it gets interesting.

The previous observational history is not explicitly "maintained" in the sense that the system "remembers" past collapses. Wave function collapse is irreversible because information about the original wave function is lost during the collapse. Unless we adopt the many-worlds interpretation, where information is not truly lost but becomes irretrievable, collapse remains a black box. Each collapse is independent, and the system responds to the specific measurement being made at that moment. Collapse is quantum decoherence. Quantum decoherence shows that when a quantum system interacts with the environment, superpositions seemingly reduce to mixtures of classical alternatives. However, decoherence alone does not fully explain the collapse to a single eigenstate. The combined wave function of the system and environment still obeys

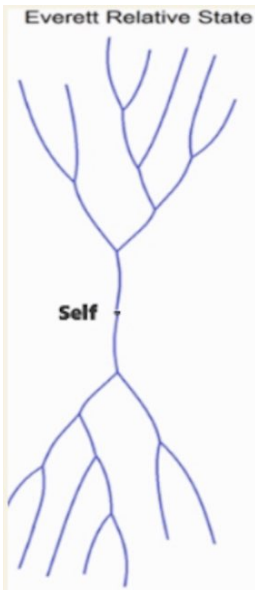
the Schrödinger equation throughout this apparent collapse. Some argue that the necessity of wave function collapse can be bypassed by considering the environment. Each part of the environment "sees" only its corresponding quantum state, effectively collapsing the system's wave function for each environment component. In practice this amounts to preserving energy levels in which potential energy is lower than kinetic energy. This technique is used in quantum computing in something called 'pure gates'. It also implies that energy boundaries which are more like drawing a circle of the face on infinity are drawn carefully. The full superposition persists in the universal wave function, but unitary time evolution has occurred. While classical observables play a role in measurement, the exact mechanisms behind wave function collapse remain an active area of research and interpretation in quantum mechanics.

Before any observation, the system can exist in a superposition of states. For example, an electron can be both spin-up and spin-down simultaneously until measured. Each collapse narrows down the possibilities, but the system doesn't retain a memory of its past states. There are experiments (such as the delayed-choice quantum eraser) that demonstrate how seemingly erased information can be "retrieved" by manipulating the measurement setup. These experiments challenge our classical intuitions about causality and history. Quantum systems don't maintain a continuous history as we perceive it classically. Each collapse is an isolated event, and the system responds to the specific measurement context. The concept of "memory" doesn't apply in the same way as it does in our macroscopic world. Decoherence destroys histories because any time the wave function collapses it decoheres. 298

Everett and the Self

I want to point out something here about the self, each one of us. We are an entangled system continuously entangling and unentangling with other systems and other Homo sapiens, animals,

planets, and what we call ‘matter’. I simply call all of this *phusis*. I showed half of this diagram a little earlier referring to Everett’s relative state (many-worlds) branching. Time goes forward as the diagram goes up and backward as the diagram goes down. We are born somewhere in the lower half of this diagram in a state of superposition, “Everything everywhere All at Once.” We die somewhere along the upper part of the diagram.



It might look like our lifetime is the length of the line which connects the upper and lower part of the diagram but that would be wrong. That line is simply an exaggeration for clarity. The real case is that our lifetime is the hypothetical dot next to the text, “Self.” We call this the ‘now moment’ but that is wrong as well. Why? Because that derives from the fall into classicism. This is the quantum wave function branching. In our common vernacular we say that the only thing which remains the same is change. This temporal diagram is what the quantum wave function terms

unitarity. The point is what the Copenhagen interpretation called collapse and what Everett's interpretation calls branching. But here is the rub. Whatever you call it, all the other branches are just as 'real' (to use the classical term), although the somewhat misleading diagram makes it look unitary. Unitarity, going forward or backward in time is an important assumption in the quantum wave function. But as I have pointed out superposition is a-temporal. Superposition is "Everything, Everywhere All at Once." I will discuss unitarity much more later.

One more important thing I want to point out now which I will return to in other ways later. This diagram looks like a tree with its rhizome reaching upwards and simultaneously downwards. Could the wave function, the tree of life (*etz chaim*) we fall from, defy classical hierarchical structures and binary dualisms in favor of pluralities which far exceed the soil it springs from? Could the network of rhizomic life like the wave function find no origin with its chaotic branching of all simultaneous possibilities? More on that later.

Metaphors in Superposition - Energy, Heat, Entropy, and the Direction of Time in Thermodynamic Equilibrium

Time and space – nothing physical exists in the quantum wave function. Even more, existence does not exist in the quantum wave function. And neither is there any such notion as the 'not' of existence - nonexistence. This is because there is an excess to the quantum wave function which spills into our realities in the spooky observer effect. In nonclassical superposition there is no such thing as energy, heat, or entropy as we see and feel in the classical world but there are 'analogs' which can be reflected upon state reduction into classicism. Physicists actually have a name for these 'analogs' – semiclassical. However, these are not really 'analogs' or metaphors, because physical properties have very spooky relationships to certain aspects of the quantum wave function and its branching into

classicism. This will be discussed in more detail throughout the book. As we saw in the previous section, the classical reduction state can find temporal analogs like the classical Fourier transformation in superposition which give us clues about how the complex wave function might be dissected into classical sine waves. We also saw how classical time itself and unitarity in the time dependent wave function served as an analog, a metaphor, for an event which defied classical temporality in its "Everything Everywhere All at Once." In this section, I want to explore how energy, heat, and entropy phenomena in our classical spacetime manifold may also have 'analogs' to superposition. Additionally, I want to look at how classical thermal equilibrium, which is a measure of steady state condition in which energy, heat, and entropy remain stable. These classical analogs are similes of the very odd condition of superposition. In all these 'analogs' we must not import our historic notions of identity between the wave function and classicism. Both superposition and the classical, 'real' world are very different. The gap between the two must remain as a necessary parenthetical of our narrative lest we once again make the mistake of reductive totalizing which claims origin and rule.

Is there energy in superposition? No, but...

In quantum mechanics, the principle of superposition states that a quantum system can exist in multiple states simultaneously. These states are mathematical (e.g., the quantum wave function) but they have no 'materiality'. Neither are they merely mathematics which corresponds mathematical equations to phenomenon, abstraction/ potential to concrete/actual which is the business of epistemology. There is some hazy middle ground which exceeds these bipolar, historic dualities wherein the gap is marked by language's awkwardness to express… Superposition does not 'radiate' energy. There is no 'there' there. Superposition has states, configurations, arrangements of information. We can compare these states and see

how they correlate to classical energy levels. But the association is not an identity. In classicism, energy is varying regions of potential and kinetic behavior over time. But in superposition we have both "Everything Everywhere All at Once." And the state reduction of the observer effect. Therefore, energy is not a phenomenon in superposition, but rather a preferred classical description of a quantum system. 300

Is there heat in superposition? No, but...

To start with, in our classical world there is heat and some forms of heat can be converted into work. A combustion engine converts heat to work but it is very ineficient so a lot of the energy is lost in the conversion. There is no such thing as classical heat in superposition but there may be a classical analog. How could we determine this? In a classical linear system if we apply a stimulus to induce a certain amount of perturbation or chaos in the system, we can look at the resulting effect to gain some understanding of how the system will react and what the limits of the system's coherence might be. So, if we want to find out what effect heat may have on superposition, we can heat a tightly controlled environmental superposition state and observe what happens upon state reduction into classicism. In the context of heat transfer, the superposition method is used to simulate the temperature history for the superposition nodes of interest. A pulse of heat is applied to a representative element like hydrogen to produce a 'data map' by something called the finite element method. A data map is a statistical sample which experimentally applies an increment of heat, measures the classical state reduction, records the value in a table or map, and then proceeds to the next increment of heat. This creates a data map of temperature history for the superposition nodes of interest. It can be used to look at quantized state reductions to an existing ideal pure state or even boundary conditions which might show relationships between one pure state

and another or mixed states only after state reduction into classicism. Therefore, it is not correct to say that there is “heat in superposition”. However, the superposition principle can be used to analyze the temperature distribution in a system that is subject to multiple heat sources. [301]

Is there entropy in superposition? No, but...

Entropy is the measure of disorder in a system. We can think of it as information which is not ordered. By this I mean there is no sequence, no cause and effect, just jumbled up information or chaos. Quantum superposition is a fundamental principle of quantum mechanics. It states that if a physical system may be in one of many configurations, then the most general state is a combination of all of these possibilities, where the amount in each configuration is specified by a complex number. In the context of quantum mechanics, entropy can be used to describe the degree of entanglement between two or more quantum systems. Entanglement is strictly a characteristic of superposition. Upon classical state reduction we can see that the mere fact of observing one property of an entangled system, without the intervention of spacetime, sets the same property value of another entangled system simultaneously which could be on the other side of the universe. Simultaneously does not mean faster than the speed of light. It means without regard to speed, time, or space. This is very different from classical notions. In the case of superposition, the entropy of a quantum system in a superposition state can be calculated using the von Neumann entropy formula. This formula is used to calculate the entropy of a mixed state, which is a state that is a probabilistic mixture of two or more pure states. We see increasing disorder, the ‘arrow of time’ physicists call entropy, but superposition sees information which has no cause and effect. We need only think about the Big Bang singularity to understand how information can be purely chaotic but take “form and void” in the

genesis of classicism and origin. 302

Is there thermal equilibrium in superposition? No, but...

In a nutshell here are the four laws of thermodynamics for classical systems:

1. Zeroth Law of Thermodynamics
    a. The Zeroth Law of Thermodynamics states that if two systems are in thermodynamic equilibrium with a third system, the two original systems are in thermal equilibrium with each other. Basically, if system A is in thermal equilibrium with system C and system B is also in thermal equilibrium with system C, system A and system B are in thermal equilibrium with each other. This is how equivalences of energy allow us to form comparisons.
2. 1st Law of Thermodynamics
    a. The First Law of Thermodynamics states that energy can be converted from one form to another with the interaction of heat, work and internal energy, but it cannot be created nor destroyed, under any circumstances. This is also called the conservation of energy.
3. 2nd Law of Thermodynamics
    a. The Second Law of Thermodynamics states that the state of entropy of the entire universe, as an isolated system, will always increase over time. The second law also states that the changes in the entropy in the universe can never be negative. This has to do with open and closed systems.

4. 3rd Law of Thermodynamics

    a. The 3rd law of thermodynamics will essentially allow us to quantify the absolute amplitude of entropies. It says that when we are considering a totally perfect (100% pure) crystalline structure, at absolute zero (0 Kelvin), it will have no entropy (S). Note that if the structure in question were not totally crystalline, then although it would only have an extremely small disorder (entropy) in space, we could not precisely say it had no entropy. This tells us about entropy, the disorder in a system. 303

The first law specifies the criterion for a spontaneous process. An example of a spontaneous process like breaking an egg on the floor and also being able to take the broken egg on the floor and reverse it back into the egg before we dropped it. Energy can change entities from one form to another and back again, but energy can never be destroyed. The second law tells us that the egg can fall on the floor, but it cannot be reversed to be a coherent egg again. The coherent egg is a form of energy in equilibrium, so its entropy is the same. However, dropping and breaking the egg on the floor increase its entropy, its disorder, its cohesiveness but like Humpy Dumpty, all the king's horses and all the king's men cannot put the egg back together again. In an open system with the environment the system cannot achieve less entropy. Entropy or disorder can only stay the same or increase. Just as temperature has an absolute zero Kelvin which can never 'exist' but is only an absolute limit which can never be achieved, the third law tells us the absolute zero of entropy can never 'exist' but is only an absolute limit which can never be achieved, or it can only exist with the same amount of disorder or the melting away of order. Another way to think about this is that the production of heat by friction is irreversible. When friction does not cause displacement, motion, or

the direction of friction is perpendicular to the displacement, motion, it does not work. However, even if friction does not work it still increases entropy in a system. Friction can produce work. Just think about brakes on a car. And as mentioned, heat can also produce work like a combustion engine. But since entropy is a measure of disorder or randomness in a system, it is also an indicator of how much energy is not available to do work. It is inversely related to efficiency.

Classically, thermal equilibrium is a state where the temperature of a system is uniform throughout and does not change over time. When a system is in thermal equilibrium, there is no net flow of heat between the system and its surroundings. The concept of thermal equilibrium is closely related to the second law of thermodynamics, which states that the entropy of an isolated system never decreases, and in equilibrium, the entropy stays the same. In a thermodynamic equilibrium system with a given energy, the entropy is greater than that of any other state with the same energy. When the system reaches equilibrium, the free energy change (ΔG) is zero, and the system has reached the minimum free energy. Thermal equilibrium is a state of minimum free energy, where the entropy of an isolated system never decreases, and in equilibrium, the entropy stays the same.

In all four of these laws, we can see the dynamic interplay (equilibrium) of heat (thermal), energy (1^{st} law), and entropy (2^{nd} and 3^{rd} laws). It is best to think of thermal equilibrium and its four laws as hills and valleys in a landscape. These four laws lay out the landscape where hills and valleys, degrees of potential versus kinetic energy, determine how much work can be achieved. Suppose our hill and valley are covered with snow and we have skis on at the top of the hill. At the top of the hill, we are in equilibrium. With just a slight push we can convert all that potential energy into kinetic energy as we glide down the hill. But if we wipe out and hit a tree our system's entropy has increased as ski patrol takes us down the hill and no more useful work can be

performed.

The bottom line is that energy potential has many ways of manifesting itself in phenomena which can produce useful work by actualizing it into kinetic energy. In a closed system, sealed off from the rest of the universe, thermal equilibrium can be maintained meaning the order in a system cannot change, entropy remains constant, and like the perpetual machine heat can be recycled into useful work with 100% efficiency and no net increase in entropy. But an absolutely closed system is impossible and so is a perpetuating machine. Any leakage into the environment will always increase entropy. Since the Big Bang singularity entropy has been increasing. On the flip side this means information complexity has been increasing. If we were in a closed system informational complexity would reach a limit where no more combination of all informational possibilities could be achieved. Every combination would be exhausted so all we could do is just replay the combinations perpetually, forever, like Nietzsche's eternal recurrence of the same and like Hilbert space. There could be no emergent or novel degrees of freedom, absolutely new possibilities. This would be the absolute humdrum doldrums. But we know that entropy is always going to stay the change or increase. We know that this one-way arrow of entropy is the arrow of time. This is the classical world. So, what does superposition have to do with all this? 304

In the wave function there is an operator called the 'operator entangled entropy'. This operator is used to study the onset of quantum chaos and the 'thermalization of the system'. As mentioned above there is no such thing as 'heat' in the wave function (that is all ontic, having to do with classical existence). But there are distinct states which are not pure idealized states but mixed states which 'simultaneously morph' (a Zen koan) and actually allow us to probabilistically add these simultaneous morphed states into predications about state reductions into classicism upon observation. Quantum decoherence is the loss of

quantum coherence, the process in which a system's behavior changes from that which can be explained by quantum mechanics to that which can be explained by classical mechanics. It is state reduction, collapse, branching, etc. When entangled systems in superposition become entangled with the observer, e.g., the measuring device, they decohere into classicism. So, while entanglement is not entropy, an analog, metaphorical, kind of entropy which is decoherence of the wave function can be likened to what happens in our classical world in terms of entropy. Entropy is a kind of decoherence. Decoherence is very real for us older folks. But in the quantum wave function something bizarrely different occurs than in our 'real' world.

In state reduction to classicism information from the wave function is not 'lost'. It just becomes inaccessible to us. The wave function has no 'knowledge' of state reduction or classicism. All possibilities are happening "Everything Everywhere All at Once", at the same time or what I simply write as simultaneously. Therefore, the Copenhagen interpretation which simply throws away all other avenues of lost information in the wave function in favor of one branch of wave function decoherence is a myopic view which, in my thinking, values origin in its most classical sense. The failure of history to understand ancient intuitions about chaos has derailed us all into power structures which claim authority and rule and also totalize 'reality' driving any excess to its narrative into oblivion. This is what we call violence. Violence has played its final performance. If nothing else, what faces us in nuclear extermination and climate change brings us to the final curtain call. The final curtain call has no actors, no cast, no other, only eternal echoes of unrelenting dramas, Nietzsche's reoccurrence of the same. 305

The Ancient Middle Voice and Everett

There are some interesting correlations with the quantum wave function and ancient uses of the middle voice. For many years, a

philosopher friend of mine has been enthusiastic about Charles Bigger's idea of the middle voice. The middle voice is found in almost all ancient languages. It is one of the oldest parts of linguistic grammar. It is found in ancient Greek, Latin, and Sanskrit and in some modern language groups like Romance, Slavic, Germanic, except English, and non-Indo-European languages.[306] In our current language it is used less frequently. A case study about the middle voice in ancient Greece shows that some of the richness of the middle voice has been lost among some linguists. R.J. Allan, a professor at the University of Amsterdam, argues that the modern prototypical transitive event which is often wrongly associated with the middle voice in ancient Greek codes an unmarked active voice. As such, it misunderstands an important nuance of the ancient Greek middle voice which he describes as subject-affectedness. In other words, the Greek middle voice did not convey a hidden agent which was acting on a passive object for example. Rather, there is an affectivity which changes as it is being changed.

> The prototypical transitive event is coded by the unmarked active voice. I have argued that the middle voice can be defined as a marked coding of a departure from the prototypical transitive event. Contrary to the prototypical transitive, the middle voice codes that the subject is affected by the event. In other words, the subject, in some way or other, undergoes an effect of the event…
>
> It was argued that, in Ancient Greek, the middle voice is the marked member in a privative opposition with the active voice. In sum, the middle voice expresses the presence of the semantic property of subject-affectedness. The active voice, on the other hand, is neutral with respect to affectedness…
>
> The semantic property of subject-affectedness can be considered the abstract schema of the Ancient Greek middle voice. The various middle uses can be seen as elaborations of this schema.[307]

The way I understand it, the middle voice is not active or passive. It is a combination of both active and passive or some of both like superposition. The middle voice is not from a subject acting on an object or an object acting on a subject. It is both subjectivity and objectivity not yet thought of as such - acting together, in unison, which, later in linguistics, gets taken up as the subject of an active, but hidden, agent according to Allan. Think about it this way:

The dancer [is] dancing and dancing [is] the dancer.

Here, dancer and dancing, dancing and dancer are both transformed as a simultaneous co-arising. Our common use of the word 'Being', encapsulated in the small word 'is', was not yet viable in ancient Greece as we understand it post-modernity. The ancient Greek middle voice is an interesting case and point of this. However, Everett's notion cannot be reduced to a lost voice of language. The almost subconscious everyday viability of subject/object, active/passive, its ability to work successfully in commonsense usage, comes as a product of our history, our language, our inability to think the '*is*' without dividing 'reality' up into passive and active. Schrödinger's quantum wave function '*is*' the middle voice of Everett's many-worlds notion where information branching off in observational updates are both 'reality' and ourselves; both are irretrievably changed.

Everett's many-worlds theory as informational updates branching off upon observation using Schrödinger's wave equation is a direct result of entangled information which I will get into later. At times in this book, I will draw from the Everettian school. [i] For now, I just want to give a little biographical update on Hugh Everett.

> Hugh Everett III; November 11, 1930 – July 19, 1982) was an American physicist who first proposed the many-worlds interpretation (MWI) of quantum physics, which he termed his "relative state" formulation. In contrast to the then-

> dominant quantum physics, the MWI posits that the wave function never collapses and that all possibilities of a quantum superposition are objectively real.
>
> Discouraged by the scorn of other physicists for MWI, Everett ended his physics career after completing his PhD. Afterwards, he developed the use of generalized Lagrange multipliers for operations research and applied this commercially as a defense analyst and a consultant. In poor health later in life, he died at the age of 51 in 1982. He is the father of musician Mark Oliver Everett.
>
> Although largely disregarded until near the end of Everett's lifetime, the MWI [many worlds' interpretation] received more credibility with the discovery of quantum decoherence in the 1970s and has received increased attention in recent decades, becoming one of the mainstream interpretations of quantum mechanics alongside Copenhagen, pilot wave theories, and consistent histories.[308]

Everett was born in 1930. At the age of twelve he wrote a letter to Einstein asking whether he thought the universe was random or unifying. Einstein replied,

> Dear Hugh: There is no such thing like an irresistible force and immovable body. But there seems to be a very stubborn boy who has forced his way victoriously through strange difficulties created by himself for this purpose. Sincerely yours, A. Einstein.[309]

Everett received a National Science Foundation fellowship which allowed him to attend graduate studies at Princeton University. He started in mathematics but drifted into physics. His thesis adviser was John Wheeler, a very prominent physicist in the history of physics. Wheeler actually traveled to Copenhagen in 1956 in part to obtain favor from leading world physicists concerning Everett's

work. Everett worked at the Pentagon for a while. In 1959 Everett traveled to Copenhagen to meet with Niels Bohr to discuss the Copenhagen interpretation of quantum physics. It was a disaster. His idea was that the wave function does not objectively collapse. In 1962, Everett presented a paper with his derivation of probability and stating explicitly that observers in all branches of the wave function were equally ‘real’. Everett’s personal life was tragic to say the least.

> Everett's daughter, Elizabeth, died by suicide in 1996 (saying in her suicide note that she wished her ashes to be thrown out with the garbage so that she might "end up in the correct parallel universe to meet up w[ith] Daddy"),[22] and in 1998, his wife, Nancy, died of cancer. Everett's son, Mark Oliver Everett, who found Everett dead, is also known as "E" and is the main singer and songwriter for the band Eels. The Eels album Electro-Shock Blues, which was written during this time period, is representative of these deaths.[310]

Hugh Everett was discredited during his life and died at the age of fifty-one only to posthumously be recognized for important contributions to 20th century physics.

> At the age of 51, Everett, who believed in quantum immortality, died suddenly of a heart attack at home in his bed on the night of July 18–19, 1982. Everett's obesity, frequent chain-smoking and alcohol drinking almost certainly contributed to this, although he seemed healthy at the time. A committed atheist, he had asked that his remains be disposed of in the trash after his death. His wife kept his ashes in an urn, but she eventually complied with his wishes after a few years.[311]

Also, I found this spin off from one of Everett’s ideas very

interesting,

> Quantum suicide is a thought experiment in quantum mechanics and the philosophy of physics. Purportedly, it can falsify any interpretation of quantum mechanics other than the Everett many-worlds interpretation by means of a variation of the Schrödinger's cat thought experiment, from the cat's point of view. Quantum immortality refers to the subjective experience of surviving quantum suicide. This concept is sometimes conjectured to be applicable to real-world causes of death as well.
>
> As a thought experiment, quantum suicide is an intellectual exercise in which an abstract setup is followed through to its logical consequences merely to prove a theoretical point. Virtually all physicists and philosophers of science who have described it, especially in popularized treatments, underscore that it relies on contrived, idealized circumstances that may be impossible or exceedingly difficult to realize in real life, and that its theoretical premises are controversial even among supporters of the many-worlds interpretation. Thus, as cosmologist Anthony Aguirre warns, "[...] it would be foolish (and selfish) in the extreme to let this possibility guide one's actions in any life-and-death question."[312]

A Brief History of the Quantum Wave Function

In 1900 Max Planck (1858-1947) proposed that the proportionality of the frequency of the photon and its energy was proportional to Planck's constant: E = h times f, where E is energy, h is Planck's constant, and f is frequency. Subsequently in 1916 he proposed the relation between a photon's momentum and wavelength:

$$\lambda = \frac{h}{p}$$

Lambda, the left side of the equation, is wavelength, h-bar is Planck's constant, and p is momentum. De Broglie in 1932 was the first to generalize this to massive particles. This is understood as the starting point for the development of modern quantum mechanics. This was the beginning of wave-particle duality for massless and massive particles.

You can think of cycles per second and radians as the unit of a single "turn." When used like this Planck's Constant is the "Whole Circle" version. It represents the energy of one complete cycle. Use this when you are talking about waves stretching out in space or vibrating over time (Hertz). Planck's reduced constant is the "single step" version. It represents the energy of just one radian (about 1/6th of a circle). Use this when you are talking about rotation, spin, or the internal "clock" of a particle.

A Simple Metaphor:

If a quantum particle is a dancer spinning Planck's constant is the energy of one full pirouette (whirl or spin 360 degrees), while Planck's reduced constant is the energy of moving just one arm's length along that circle. Physicists prefer radians because nature's math is "circular"—it's much cleaner to calculate a dance step-by-step than to keep track of every loop.

In the 1920s and 1930s quantum mechanics was married to calculus and linear algebra. Louis de Broglie, Erwin Schrödinger, and others pioneered wave mechanics. Werner Heisenberg, Max Born, and others, developed "matrix mechanics" using linear algebra. Schrödinger subsequently showed that the two approaches were equivalent.

In 1926 Schrödinger published his famous wave equation. In 1926 Born provided his famous probability amplitude. This became part of the Copenhagen Interpretation of quantum physics. There are many other interpretations that will be discussed soon. Schrödinger actually founded a relativistic equation for the wave equation which applies to velocities close to or equal to (for massless particles like photons) the speed of light. However, the Klein-Gordon equation is the most commonly known equation for this.

In 1927 Pauli found a non-relativistic equation for 1/2 spin particles. In 1928 Dirac found an equation which unified special relativity and quantum mechanics. 313

Schrödinger's Philosophy

Schrödinger was highly acquainted with Eastern and Western philosophy. He was a complex man. In this section I want to explore some of his multifarious philosophies. I found this particularly interesting. In Schrödinger's famous book entitled "What is Life" he investigates life and biology from a quantum physics point of view. Schrödinger explains that most physical laws on a large scale are due to chaos on a small scale. He calls this "order-from-disorder". He gives an example of diffusion which can be modeled as a highly ordered process but is nevertheless caused by random movement of atoms and molecules. As the numbers of atoms are reduced the system behavior becomes increasingly random. At the end of chapter 7 in the epilog Schrödinger gives us his notion of consciousness. The atman is oneself in Buddhism. The Brahman is ultimate reality.

> Schrödinger concludes this chapter and the book with philosophical speculations on determinism, free will, and the mystery of human consciousness. He attempts to "see whether we cannot draw the correct non-contradictory

conclusion from the following two premises: (1) My body functions as a pure mechanism according to Laws of Nature; and (2) Yet I know, by incontrovertible direct experience, that I am directing its motions, of which I foresee the effects, that may be fateful and all-important, in which case I feel and take full responsibility for them. The only possible inference from these two facts is, I think, that I – I in the widest meaning of the word, that is to say, every conscious mind that has ever said or felt 'I' – am the person, if any, who controls the 'motion of the atoms' according to the Laws of Nature". Schrödinger then states that this insight is not new and that the Upanishads considered this insight of "ATMAN = BRAHMAN" to "represent quintessence of deepest insights into the happenings of the world." Schrödinger rejects the idea that the source of consciousness should perish with the body because he finds the idea "distasteful". He also rejects the idea that there are multiple immortal souls that can exist without the body because he believes that consciousness is nevertheless highly dependent on the body. Schrödinger writes that, to reconcile the two premises,

"The only possible alternative is simply to keep to the immediate experience that consciousness is a singular of which the plural is unknown; that there is only one thing and that what seems to be a plurality is merely a series of different aspects of this one thing…:

Any intuitions that consciousness is plural, he says, are illusions. Schrödinger is sympathetic to the Hindu concept of Brahman, by which each individual's consciousness is only a manifestation of a unitary consciousness pervading the universe — which corresponds to the Hindu concept of God. Schrödinger concludes that "...'I' am the person, if any, who controls the 'motion of the atoms' according to the Laws of Nature." However, he also qualifies the conclusion as "necessarily subjective" in its "philosophical implications". In

> the final paragraph, he points out that what is meant by "I" is not the collection of experienced events but "namely the canvas upon which they are collected." If a hypnotist succeeds in blotting out all earlier reminiscences, he writes, there would be no loss of personal existence — "Nor will there ever be." 314

These specific phrases from the table are the exact ones Schrödinger was referencing when he discussed **Atman = Brahman**.

• **Aham Brahmasmi** ("I am Brahman") and **Tat Tvam Ash** ("Thou art that") are the core pillars of the "singular consciousness" theory he proposed in his epilogue.

• The table captures the "identity" he felt resolved the paradox between the mechanism of the body and the freedom of the mind.

Not only were these guys physicists they were also well-read philosophers. They fully understood that these findings struck at the foundations of philosophy and common sense. Schrödinger tells us that the Atman and the Brahman are one. The Upanishads were responsible for ushering in Hinduism from older archaic rituals. The oldest sacred texts of Hinduism are called the Vedas. Some of the most important written ideas in the Vedas come from a group of texts called the Upanishads. Scholars believe these texts were written somewhere from 700 BC to 300 BC. Interesting enough around that same time some of the most well-known Greek philosophers like Thales of Miletus (624-546 BCE), Pythagoras (570-495 BCE), Democritus (460-370 BCE), Socrates (470-399 BCE), Plato (427-347 BCE), and Aristotle (384-322 BCE) were also writing important texts for Western history. There are thirteen principal or important texts called the *mukha*. The authorship of these texts is unknown and believed to both male and female sages. One of the greatest insights of the *mukha* is that the Atman and the Brahman are one. The Atman is the self. Earlier I wrote about chaogenesis, which I made up to indicate growth ‘to grow-

(wo)man'. Brahman for the Upanishads is the ultimate eternal, constant reality. In the West we may think self and other, subjectivity and objectivity, mind and matter, etc. While various schools of early Hinduism treated the Atman and Brahman as absolutely distinct the great insight of the Upanishads was the Atman and Brahman are one.

> Brahman as well the Atman in every human being (and living being) is considered equivalent and the sole reality, the eternal, self-born, unlimited, innately free, blissful Absolute in schools of Hinduism such as the Advaita Vedanta and Yoga. Knowing one's own self is knowing the God inside oneself, and this is held as the path to knowing the ontological nature of Brahman (universal Self) as it is identical to the Atman (individual Self). The nature of Atman-Brahman is held in these schools, states Barbara Holdrege, to be as a pure being (sat), consciousness (cit) and full of bliss (ananda), and it is formless, distinctionless, nonchanging and unbounded. 315

As mentioned in Sanskrit *tat tvam asi* meant, "Thou art that" meaning you, the Atman, are reality, the Brahman.

Upanishad

Text	Upanishad	Translation
अहं ब्रह्म अस्मि *aham brahmāsmi*	Brihadaranyaka Upanishad	"I am Brahman"
अयम् आत्मा ब्रह्म *ayam ātmā brahma*	Brihadaranyaka Upanishad	"The Self is Brahman"
सर्वं खल्विदं ब्रह्म *sarvam khalvidam brahma*	Chandogya Upanishad	"All this is Brahman"
एकमेवाद्वितीयम् *ekam evadvitiyam*	Chandogya Upanishad	"That [Brahman] is one, without a second"
तत्त्वमसि tat tvam asi	Chandogya Upanishad	"Thou art that" ("You are Brahman")
प्रज्ञानं ब्रह्म *prajnānam brahma*	Aitareya Upanishad	"Wisdom is Brahman"

In Schrödinger's epilogue to "What is Life?" he writes,

In Christian terminology to say: 'Hence I am God Almighty' sounds both blasphemous and lunatic. But please disregard these connotations for the moment and consider whether the above inference is not the closest a biologist can get to proving also their God and immortality at one stroke.

In itself, the insight is not new. The earliest records to my knowledge date back some 2,500 years or more. From the early great Upanishads the recognition ATHMAN = BRAHMAN upheld in (the personal self equals the omnipresent, all-comprehending eternal self) was in Indian thought considered, far from being blasphemous, to represent the quintessence of deepest insight into the happenings of the world. The striving of all the scholars of Vedanta was, after having learnt to pronounce with their lips, really to assimilate in their minds this grandest of all thoughts.

Again, the mystics of many centuries, independently, yet in perfect harmony with each other (somewhat like the particles in an ideal gas) have described, each of them, the

unique experience of his or her life in terms that can be condensed in the phrase: DEUS FACTUS SUM (I have become God).

To Western ideology the thought has remained a stranger, in spite of Schopenhauer and others who stood for it and in spite of those true lovers who, as they look into each other's eyes, become aware that their thought and their joy are numerically one - not merely similar or identical; but they, as a rule, are emotionally too busy to indulge in clear thinking, which respect they very much resemble the mystic.

This life of yours which you are living is not merely a piece of this entire existence, but in a certain sense the whole; only this whole is not so constituted that it can be surveyed in one single glance. This, as we know, is what the Brahmins express in that sacred, mystic formula which is yet really so simple and so clear; tat tvam asi, this is you. Or, again, in such words as "I am in the east and the west, I am above and below, I am this entire world. 317

'If finally we look back at that idea of [Ernst] Mach [1838-1916], we shall realize that it comes as near to the orthodox dogma of the Upanishads as it could possibly do without stating it expressis verbis. The external world and consciousness are one and the same thing.' 318

Nirvana is a state of pure blissful knowledge... It has nothing to do with the individual. The ego or its separation is an illusion. Indeed in a certain sense two "I"'s are identical namely when one disregards all special contents — their Karma. The goal of man is to preserve his Karma and to develop it further... when man dies his Karma lives and creates for itself another carrier. 319

Although I think that life may be the result of an accident, I

do not think so of consciousness. Consciousness cannot be accounted for in physical terms. For consciousness is absolutely fundamental. It cannot be accounted for in terms of anything else. 320

The multiplicity is only apparent. This is the doctrine of the Upanishads. And not of the Upanishads only. The mystical experience of the union with God regularly leads to this view, unless strong prejudices stand in the way. 321

Multiplicity is only apparent, in truth, there is only one mind... 322

The plurality that we perceive is only an appearance; it is not real. Vedantic philosophy... has sought to clarify it by a number of analogies, one of the most attractive being the many-faceted crystal which, while showing hundreds of little pictures of what is in reality a single existent object, does not really multiply that object... 323

It is not possible that this unity of knowledge, feeling and choice which you call your own should have sprung into being from nothingness at a given moment not so long ago; rather this knowledge, feeling, and choice are essentially eternal and unchangeable and numerically one in all men, nay in all sensitive beings. But not in this sense — that you are a part, a piece, of an eternal, infinite being, an aspect or modification of it... For we should then have the same baffling question: which part, which aspect are you? what, objectively, differentiates it from the others? No, but, inconceivable as it seems to ordinary reason, you — and all other conscious beings as such — are all in all. Hence, this life of yours... is, in a certain sense, the whole... This, as we know, is what the Brahmins express in that sacred, mystic

formula... '*Tat tvam asi*' — this is you. Or, again, in such words as 'I am in the east and in the west, I am below and above, I am this whole world.'

Thus you can throw yourself flat on the ground, stretched out upon Mother Earth, with certain conviction that you are one with her and she with you … For eternally and always there is only now, one and the same now; the present is the only thing that has no end. 324

Schrödinger's idea of consciousness was highly influenced by Eastern and Western philosophy. Schrödinger goes on to explain that "Consciousness is never experienced in the plural, only in the singular." He goes on to explain what he means by this,

Consciousness finds itself intimately connected with, and dependent on, the physical state of a limited region of matter, the body. (Consider the changes of mind during the development of the body, at puberty, ageing, dotage, etc., or consider the effects of fever intoxication, narcosis, lesion of the brain and so on.) Now there is a great plurality of similar bodies. Hence the pluralization of consciousnesses or minds seems a very suggestive hypothesis. Probably all simple, ingenuous people, as well as the great majority of Western philosophers, have accepted it.

It leads almost immediately to the invention of souls, as many as there are bodies, and to the question whether they are mortal as the body is or whether they are immortal and capable of existing by themselves. The former alternative is distasteful while the latter frankly forgets, ignores or disowns the fact upon which the plurality hypothesis rests. Much sillier questions have been asked: Do animals also have souls? It has even been questioned whether women, or only men, have souls.

Such consequences, even if only tentative, must make us

suspicious of the plurality hypothesis, which is common to all official Western creeds. Are we not inclining to much greater nonsense, if in discarding their gross superstitions we retain their naive idea of plurality of souls, but 'remedy' it by declaring the souls to be perishable, to be annihilated with the respective bodies?

The only possible alternative is simply to keep to the immediate experience that consciousness is a singular of which the plural is unknown; that there is only one thing and Even in that what seems to be a plurality is merely a series of different personality aspects of this one thing, produced by a deception (the Indian MĀYĀ); the same illusion is produced in a gallery of mirrors, and in the same way Gaurisankar and Mt Everest turned out to be the same peak seen from different valleys.

There are, of course, elaborate ghost-stories fixed in our minds to hamper our acceptance of such simple recognition. E.g. it has been said that there is a tree there outside my window but I do not really see the tree. By some cunning device of which only the initial, relatively simple steps are itself explored, the real tree throws an image of itself into my physical consciousness, and that is what I perceive. If you stand by my side and look at the same tree, the latter manages to throw an image into your soul as well. I see my tree and you see yours (remarkably like mine), and what the tree in itself is we do not know. For this extravagance Kant is responsible. In the order of ideas which regards consciousness as a *singulare tantum* it is conveniently replaced by the statement that there is obviously only one tree and all the image business is a ghost-story.

Yet each of us has the indisputable impression that the sum total of his own experience and memory forms a unit, quite distinct from that of any other person. He refers to it as 'I' and What is this 'I'? If you analyse it closely you will, I

> think, find that it is just the facts little more than a collection of single data (experiences and memories), namely the canvas upon which they are collected. And you will, on close introspection, find that what you really mean by 'I' is that ground-stuff upon which they are collected. 325

Schrödinger elaborates on his monist view of consciousness as the "*one thing and that what seems to be a plurality is merely a series of different personality aspects of this one thing*". His criticism of Kant's idea of the 'thing-in-itself' is a kind of universal agnosticism of everything. For Kant, wouldn't the unknowable thing-ish-ness even pervade the "I"? Schrödinger tells us in his criticism of Kant - "*He [Kant] refers to it as 'I'."* Schrödinger says the quiet part out loud here in saying Kant refers to '*it*' as I. The 'it' has imputed a quality on the agnosticism Kant wants to maintain about the 'thing-in-itself'. The 'it' is neutrality. It has found its adjective. The 'thing-in-itself' has become ontological. 'It' has found itself in spacetime existent as neutrality. As I wrote about in a post, 'neutrality' was not always this neuter of 'things', objects', 'substance'. Neutrality acquires its ontological meaning or presence in history which poses as a quality of the 'is'. Here is one example where the neuter as a thing had not yet arrived in ancient Greece.

> While the myths of the ancient Greeks indicate a kind of animate vitalization of phusis as we see in the pantheon of gods, the notion of 'neuter' in ancient Greek was 'neither one nor the other' as in 'not masculine or feminine'. The neuter was the 'not' in ancient Greek of gender. The negative does not specify a positive term as modern usage does of the 'it' (i.e., substance, inanimate objects, not alive, thing, etc.). Furthermore, as we will see later in this text χάος in Ancient Greek can be used in different ways including the feminine gender. What is more, even the idea of χάος [chaos or yawning gap] as nothing, the void, night or disorder was

inferred later. 326

For Kant, the ‘thing-in-itself’ could not even be a negative. The ‘thing-in-itself’ could not even take on neutrality or negativity. It was absolutely agnostic. Could we call it mystic? Well, Hegel took Kant this way and went to tell us how to fix Kant. But that is another subject. Schrödinger goes on to write, *“and What is this 'I'? If you analyse it closely you will, I think, find that it is just the facts little more than a collection of single data (experiences and memories), namely the canvas upon which they are collected. And you will, on close introspection, find that what you really mean by 'I' is that ground-stuff upon which they are collected.*” The ATMAN = Brahman of Buddhism seems to me to be more of an undecidable reciprocity between me as self and other as ultimate reality or the oneness of what we think as reality. Schrödinger seems to me to be attracted to a kind of skepticism of the self as illusory, a canvas, upon which ‘the all’ is projected. I can see how he arrives at this from his knowledge of the quantum wave function, but I think there is more to the wave function in its branching which cannot be eroded by the universality327 of the wave function. I find it to be a reciprocity which does not negate one for the other.

Schrödinger himself takes a ‘mystic’ step here into his inherited history of thinking the subject as a kind of thing which is “*just the facts*”, “*little more*” than a “*collection of single data*”, “*experiences and memory*” as the ethereal “*canvas*” and of some philosophical “*ground-stuff*”. In all these accusations he perhaps more subtly names subjectivity as the metaphysical history of ‘things’ which Kant has at least tried to make explicit to us. Kant is telling us that this odd notion of ‘thing’ gets repeated all the time in our thinking without ever stopping to think why we go on renaming and reexplaining the redundant notion of thingness. Simply repeating a historic idea as if it was self-evident in my estimation repeats ‘*isness*’. The banal repetition of the unknowable thing-in-itself, the ‘*is*’ of history then must be purely self-evident or transcendental. So,

Kant is recognizing a certain history of assumed knowledge already understands the 'thing-in-itself' in 'commonsense', in the blanket assumption and acceptance that we all know what the 'thing' 'is'. As self-evident history endows this unknown 'it' as neither male nor female with the rule of origin in 'its' universality. Could this be the ultimate 'not', '*he who must not [cannot] be named*'? It seems Schrödinger's 'I' as the drop of water in the ocean of the wave function also reflects this absolute 'not'. However, at this point Schrödinger takes an unexpected turn.

We read how Schrödinger's universal takes on the predicates of Brahman. However, Schrödinger's subjectivity, the Atman, is also made to stand under the auspices of classical objectivity and commonsense. Schrödinger would have never accepted this when it came to classical physics and the revolutionary findings of his own quantum mechanics. It seems to me that the Upanishads understanding of Atman would have more to do with Schrödinger's quantum physics than his explanations of the mechanics of subjectivity. The West has also suffered from this myopia in naming the Atman as a mystic illusion of LaPlace's demon or metaphysics' God. The Upanishads did not have this convenient history of modernism to process subjectivity as simply another set of "*facts*" and "*collection of single data.*" Upon which the mysterious words "*canvas*" and "*ground-stuff*" sufficed as the depository of these 'things'. When it came to quantum physics Schrödinger tells us that Einstein's description of entanglement as "spooky action at a distance" is "*the characteristic trait of quantum mechanics*". Even more, here are some quotes attributed to Schrödinger,

> Mind is by its very nature a singulare tantum. I should say: the over-all number of minds is just one. I venture to call it indestructible since it has a peculiar timetable, namely mind is always now. There is really no before and after for mind. There is only a now that includes memories and expectations. But I grant that our language is not adequate to

> express this, and I also grant, should anyone wish to state it, that I am now talking religion, not science – a religion, however, not opposed to science, but supported by what disinterested scientific research has brought to the fore. 328

> Now let us turn to these two principles themselves. As regards the first, 'that nature can be understood', I will say here only a few words. The most astonishing thing about it is that it had to be invented, that it was at all necessary to invent it. It stems from the Milesian School, the physiologoi. Since then it has remained untouched, though perhaps not always uncontaminated. The present line in physics is possibly a quite serious contamination. The uncertainty principle, the alleged lack of strict causal connection in nature, may represent a step away from it, a partial abandonment. 329

Physiologoi is Greek, plural of *physiologos*, from *physi-* + *logos* word, speech. It refers to ancient Greek philosophers of *phusis* or nature. The main three philosophers in this school were: Thales, Anaximander, and Anaximenes. They thought the origin or *arche* was made up of water, *apeiron* (unlimited), or air respectively. But in the quote above Schrödinger tells us one mind is the *arche.*

In the rather long quote below Schrödinger begins to untie the Gordian Knot of Kant which I just wrote about. The quote below gives us keen insight into Schrödinger's own inhibitions about his discovery. He is obviously not comfortable with his discoveries. He knows his findings cast serious dispersions on the subject and object as historically distinctly different. He thinks maybe future findings will tie the Gordian Knot of histories subject and object back together. He is also perplexed by the observer effect which is not passive but somehow modifies the environment in the act of observation. Neither is he comfortable with Kant's complete negation as the thing-in-itself.

We cannot make any factual statement about a given natural object (or physical system) without 'getting in touch' with it. This 'touch' is a real physical interaction. Even if it consists only in our 'looking at the object' the latter must be hit by light-rays and reflect them into the eye, or into some instrument of observation. This means that the object is affected by our observation. You cannot obtain any knowledge about an object while leaving it strictly isolated. The theory goes on to assert that this disturbance is neither irrelevant nor completely surveyable. Thus after any number of painstaking observations the object is left in a state of which some features (the last observed) are known, but others (those interfered with by the last observation) are not known, or not accurately known. This state of affairs is offered as an explanation why no complete, gapless description of any physical object is ever possible.

If this has to be granted – and possibly it has to be granted – then it flies in the face of the principle of understandability of nature. This in itself is no opprobrium. I told you at the outset that my two principles are not meant to be binding on science, that they only express what we had actually kept to in physical science for many, many centuries and what cannot easily be changed. Personally I do not feel sure that our present knowledge as yet vindicates the change. I consider it possible that our models can be modified in such a fashion that they do not exhibit at any moment properties that cannot in principle be observed simultaneously – models poorer in simultaneous properties but richer in adaptability to changes in the environment. However, this is an internal question of physics, not to be decided here and now. But from the theory as explained before, from the unavoidable and unsurveyable interference of the measuring devices with the object under observation, lofty consequences of an epistemological nature have been drawn and brought to the

fore, concerning the relation between subject and object. It is maintained that recent discoveries in physics have pushed forward to the mysterious boundary between the subject and the object. This boundary, so we are told, is not a sharp boundary at all. We are given to understand that we never observe an object without its being modified or tinged by our own activity in observing it. We are given to understand that under the impact of our refined methods of observation and of thinking about the results of our experiments that mysterious boundary between the subject and the object has broken down.

In order to criticize these contentions let me at first accept the time-hallowed distinction or discrimination between object and subject, as many thinkers both in olden times have accepted it and in recent times still accept it. Among the philosophers who accepted it – from Democritus of Abdera down to the 'Old Man of Königsberg' – there were few, if any who did not emphasize that all our sensations, perceptions and observations have a strong, personal, subjective tinge and do not convey the nature of the 'thing-in-itself, to use Kant's term. While some of these thinkers might have in mind only a more or less strong or slight distortion, Kant landed us with a complete resignation: never to know anything at all about his 'thing-in-itself. Thus the idea of subjectivity in all appearance is very old and familiar. What is new in the present setting is this: that not only would the impressions we get from our environment largely depend on the nature and the contingent state of our sensorium, but inversely the very environment that we wish to take in is modified by us, notably by the devices we set up in order to observe it.

Maybe this is so – to some extent it certainly is. May be that from the newly discovered laws of quantum physics this modification cannot be reduced below certain well-

ascertained limits. Still I would not like to call this a direct influence of the subject on the object. For the subject, if anything, is the thing that senses and thinks. Sensations and thoughts do not belong to the 'world of energy', they cannot produce any change in this world of energy as we know from Spinoza and Sir Charles Sherrington.

All this was said from the point of view that we accept the time-hallowed discrimination between subject and object. Though we have to accept it in everyday life 'for practical reference', we ought, so I believe, to abandon it in philosophical thought. Its rigid logical consequence has been revealed by Kant: the sublime, but empty, idea of the 'thing-in-itself' about which we forever know nothing.

It is the same elements that go to compose my mind and the world. This situation is the same for every mind and its world, in spite of the unfathomable abundance of 'cross-references' between them. The world is given to me only once, not one existing and one perceived. Subject and object are only one. The barrier between them cannot be said to have broken down as a result of recent experience in the physical sciences, for this barrier does not exist. 330

In 1956, very late in his life, he is lecturing at Cambridge on "Mind and Matter". Schrödinger falls back on his stern belief that mind and body are absolutely separate. But he is mystified and intrigued by mind. He knows from his own work that reality has a problem in the way it has been conceived, "*In reality! A strange reality! Something seems to be missing in it.*" At this point in his life, he is fully aware of the advances beyond his early years. He knows that what his well-read history informs him of is faltering in terms of mind and matter. He knows there is something highly philosophical about the observer effect, but he seems to be at a loss to draw any conclusions.

Mind, the anything perception can compass, goes therefore in our spatial world more ghostly than a ghost. Invisible, intangible, it is a thing not even of outline; it is not a 'thing'. It remains without sensual confirmation and remains without it forever. [a quote from Sir Charles Sherrington, in his book "Man on his Nature", Schrödinger gives 357 as the page number]

In my own words I would express this by saying: Mind has erected the objective outside world of the natural philosopher out of its own stuff. Mind could not cope with this gigantic task otherwise than by the simplifying device of excluding itself– withdrawing from its conceptual creation. Hence the latter does not contain its creator.

I cannot convey the grandeur of Sherrington's immortal book by quoting sentences; one has to read it oneself. Still, I will mention a few of the more particularly characteristic.

Physical science … faces us with the impasse that mind per se cannot play the piano – mind per se cannot move a finger of a hand (p. 222). ["Man on his Nature"]

Then the impasse meets us. The blank of the 'how' of mind's leverage on matter. The inconsequence staggers us. Is it a misunderstanding? (p. 232). ["Man on his Nature"]

Hold these conclusions drawn by an experimental physiologist of the twentieth century against the simple statement of the greatest philosopher of the seventeenth century: B. Spinoza (Ethics, Pt III, Prop. 2):

Nec corpus mentem ad cogitandum, nec mens corpus ad motum, neque ad quietem, nec ad aliquid (si quid est) aliud determinare potest.

[Neither can the body determine the mind to think, nor the mind determine the body to motion or rest or anything else (if such there be).]

The impasse is an impasse. Are we thus not the doers of our deeds? Yet we feel responsible for them, we are punished

or praised for them, as the case may be. It is a horrible antinomy. I maintain that it cannot be solved on the level of present-day science which is still entirely engulfed in the 'exclusion principle' – without knowing it – hence the antinomy. To realize this is valuable, but it does not solve the problem. You cannot remove the 'exclusion principle' by act of parliament as it were. Scientific attitude would have to be rebuilt, science must be made anew. Care is needed.

So we are faced with the following remarkable situation. While the stuff from which our world picture is built is yielded exclusively from the sense organs as organs of the mind, so that every man's world picture is and always remains a construct of his mind and cannot be proved to have any other existence, yet the conscious mind itself remains a stranger within that construct, it has no living space in it, you can spot it nowhere in space. We do not usually realize this fact, because we have entirely taken to thinking of the personality of a human being, or for that matter also that of an animal, as located in the interior of its body. To learn that it cannot really be found there is so amazing that it meets with doubt and hesitation, we are very loath to admit it. We have got used to localizing the conscious personality inside a person's head – I should say an inch or two behind the midpoint of the eyes. From there it gives us, as the case may be, understanding or loving or tender – or suspicious or angry looks. I wonder has it ever been noted that the eye is the only sense organ whose purely receptive character we fail to recognize in naïve thought. Reversing the actual state of affairs, we are much more inclined to think of 'rays of vision', issuing from the eye, than of the 'rays of light' that hit the eyes from outside. You quite frequently find such a 'ray of vision' represented in a drawing in a comic paper, or even in some older schematic sketch intended to illustrate an optic instrument or law, a

> dotted line emerging from the eye and pointing to the object, the direction being indicated by an arrowhead at the far end. –Dear reader or, or better still, dear lady reader, recall the bright, joyful eyes with which your child beams upon you when you bring him a new toy, and then let the physicist tell you that in reality nothing emerges from these eyes; in reality their only objectively detectable function is, continually to be hit by and to receive light quanta. In reality! A strange reality! Something seems to be missing in it. 331

These feelings of ambivalence are still with us long after Schrödinger. Physicists are fully aware of the implications of their discoveries in quantum physics. They have quite an aversion to entering into that quagmire as it is not conducive to a healthy career. I find their apprehension necessary and admirable as well. Physicists are creatures of high rigor and prefer conservatism with existing theory over striking out in uncharted directions. The staggering implications of their findings philosophically are shrouded in ambivalences and lack adequate empirical grounds for correlating the observer effect to macroscopic phenomenon like the mind. There have been inroads towards this in biology, neurology, and evolutionary sciences but we are still a long way off from drawing major philosophical conclusions from this research. It seems that quantum computing will give us the best opportunity towards understanding how mind, body, emotion, and sensation works. However, I maintain that there is an urgency for *Homo sapiens* to leave behind the certainties of history congealed into commonsense which has brought us to the brink of nuclear extinction and environmental disaster. History has run its course and is hollowing itself out at this moment of crisis. Reactionaryism will not find that its desperation forces a reconstitution of bygone ‘realities’. Reactionaryism only shallows itself out into the perpetual repetition of worn-out narratives. There is one notion we can be

certain of – whatever quantum physics has to ultimately tell us about ourselves is highly different from anything we have yet imagined.

From our historic vantage point now, I prefer the vocabulary of chaos and abyss to silence and retreat. What we can know is that something strange stares us in the face. In physics it is downright spooky but in our relations with each other we need to stop totalizing, believing our ideas and judgements of the other are composite with 'reality'. Schrödinger tells us this 'reality' is a manufactured reality of mind, subjective perceptions. He seems to leave us in a similar position to Kant's absolute agnosticism of the 'thing-in-itself' with regard to the subject, the 'me'. Schrödinger writes,

> In the order of ideas which regards consciousness as a singulare tantum [a noun which has no plural form, only singular] it is conveniently replaced by the statement that there is obviously only one tree and all the image business is a ghost-story. 332

Yet Schrödinger resists the pluralism of Kant's cryptic thing-in-itself.

> The only possible alternative is simply to keep to the immediate experience that consciousness is a singular of which the plural is unknown; that there is only one thing and Even in the that what seems to be a plurality is merely a series of different personality aspects of this one thing, produced by a deception (the Indian MAJA); the same illusion is produced in a gallery of mirrors, and in the same way Gaurisankar and Mt Everest turned out to be the same peak seen from different valleys.
>
> There are, of course, elaborate ghost-stories fixed in our minds to hamper our acceptance of such simple recognition.

> E.g. it has been said that there is a tree there outside my window but I do not really see the tree. By some cunning device of which only the initial, relatively simple steps are itself explored, the real tree throws an image of itself into my physical consciousness, and that is what I perceive. If you stand by my side and look at the same tree, the latter manages to throw an image into your soul as well. I see my tree and you see yours (remarkably like mine), and what the tree in itself is we do not know. 333

But isn't the thing-in-itself also a *singulare tantum,* a noun which has no plural form, only singular? In Kantian philosophy, the thing-in-itself (German: *Ding an sich*) is the status of objects as they are, independent of representation and observation. According to Kant's idealism, things in themselves—the mind-independent world—are beyond our epistemic reach and cannot be an object of cognition (or knowledge) for epistemic agents such as ourselves, that is, human beings (or perhaps finite cognizers more broadly). But isn't this exactly what Schrödinger's view of mind, consciousness, *singulare tantum* is as well? The mind does not participate in physics and nonclassical superposition. It exists always and only as a singularity, a *singulare tantum* in classical physics. But "*Then the impasse meets us. The blank of the 'how' of mind's leverage on matter.*" Let's look at a bit more of the quote above.

> For this extravagance Kant is responsible. In the order of ideas which regards consciousness as a singulare tantum it is conveniently replaced by the statement that there is obviously only one tree and all the image business is a ghost-story.
>
> Yet each of us has the indisputable impression that the sum total of his own experience and memory forms a unit, quite distinct from that of any other person. He refers to it as 'I' and What is this 'I'?

> If you analyse it closely you will, I think, find that it is just the facts little more than a collection of single data (experiences and memories), namely the canvas upon which they are collected. And you will, on close introspection, find that what you really mean by 'I' is that ground-stuff upon which they are collected. 334

Yet Schrödinger also tells us physics fundamentally has uncertainty and characteristic traits of simultaneity where superposition cannot simply be either possibility or actuality. Superposition cannot simply be classical but murky infinities which can only be definite upon the classical effect of observation. Even then there really is no classical resolution to all the unobserved infinites. They must have an indeterminate status regarding epistemology and ontology because superposition never really collapses as our subjective perception thinks it. The wave function only continually reappropriates and branches, Laplace's universal *singulare tantum*…or should I say Hegel's Concept? Why should consciousness simply be so different from *phusis*? Why must the subject exist as a fundamentally different kind of *singulare tantum*. The binary dualism of mind as its own *singulare tantum* is a different *singulare tanturn* from the quantum wave function – really? Yet, Schrödinger tells us,

> Consciousness finds itself intimately connected with, and dependent on, the physical state of a limited region of matter, the body…
>
> It is the same elements that go to compose my mind and the world. This situation is the same for every mind and its world, in spite of the unfathomable abundance of 'cross-references' between them. The world is given to me only once, not one existing and one perceived. Subject and object are only one. The barrier between them cannot be said to have broken down as a result of recent experience in the

physical sciences, for this barrier does not exist. 335

It seems for Schrödinger all of these essentially different *singulare tanturn's* are irrelevant to the quantum wave function which accounts for all. The many consciouses exist in their own internal thing-in-itself without another.

> Earlier I have commented on the fact that for this same reason the physical world picture lacks all the sensual qualities that go to make up the Subject of Cognizance. The model is colourless and soundless and unpalpable. In the same way and for the same reason the world of science lacks, or is deprived of, everything that has a meaning only in relation to the consciously contemplating, perceiving and feeling subject. 336

In the early to mid-20th century, Schrödinger's voice of history echoes a historic refrain which must remain hidden in its own *singulare tantum*. In this then lives the metaphysic incompatible with Schrödinger's own revolutionary work which even now lives on in the reductive materialism of modernism. However, this "ghost story" has eroded more and more giving way to the spooky and the observer collapse into the classical world while all other worlds must be relegated to the nether world, the underworld where Eurydice is condemned to live forever in the silent torment of the ghosts of the underworld.

What if the mind is not a generic reciprocity which can be me or you as if it makes no difference? Might this be yet another substance, thing-in-itself? Why must all ultimates as essence, Being, mind be unified under the rubric of sameness? Why does everything have equivalence under which it lives and moves and has its being? Hasn't the violence of equations in sameness appealed to origin, rule, and authority as the deciding outcome of the equation? When all are the same force must prevail in order to establish itself. And

what of the voice of the oppressed in where origin must determine the result of the equation? Isn't this the definition of silence?

Silence only perpetuates mediocrity and resignation. The others that we face every day—family, friends, acquaintances, strangers, ones we will never face, are not merely shadowy ideas of 'Mind'. They have an alterity to me which cannot be equivocated or totalized by me. They do not exist as my lived-spacetime. Their past is not my past. Their time is not granted by my lived-time. They are not an object of my space. They are not my self-created illusion of them. They are not illusions of the 'One'. They do exist in the neutrality of the 'All'. I am not an equality with the other. I am a responsibility to the other which cannot be measured or calculated. Later we may find that my responsibility to the other may reach far below, without measure, the me of self, of equivocation with all other 'me-s'. Even in the quantum wave function, I do not observe myself in order to branch from the wave function. There is no 'I' which stands apart from the quantum wave function and observes to branch as me. In the observer effect a scientist measures a value. But that value is not the scientist himself. Who is this other that observes me, branching me from the wave function as the observer effect. I will give you a hint – not God.

The spooky alterity we find in quantum mechanics cannot reside in either all these historic equivalences as me, the subject, or the other, the environment. Spooky alterity finds no sharp historical boundaries from 'to be or not to be'. Spooky alterity exhausts the binary dualities of history and 'commonsense. Schrödinger's fabrication of the other or all minds, as the one mind cannot be sealed in totality. Even his own extraordinary work opens towards a 'spook' in equivocation. The radical alterity we face towards the other places a demand on us as our inability to allow them to echo away into the underworld of my subjective illusion. The other contests my echoing away into the emptiness of Narcissus, the face of Eurydice as she falls into the underworld of my subjectivity. Responsibility responds to the call of the other which is not 'me'

and neither is it the 'not' of me. The other is not a binary dualism which we face. The other is a demand before choice as responsibility.

In the quote below Schrödinger emphasizes a main idea in this book. The classically derived ideas of 'reality' function as the basis of practicality and commonsense. In this sense they are useful. However, starting in the early 20th century with Einstein's relativity, quantum mechanics, phenomenology, and postmodernism classical anchors of science, religion, and philosophy began to lose their social cohesion and relevance. Absolute truths which had prevailed for centuries began to weaken and expose their injustices in many ways such as gender, sexual orientation, ethnic minorities, religious extremism, and autocratic consolidations of power. In the 19th century existentialism moves away from all this towards the individual. As Schrödinger terms it "*the concrete individual case*", "*what can really be observed*" poses the existential question, "*whether from now on we shall have to refrain from tying description to a clear hypothesis about the real nature of the world. There are many who wish to pronounce such abdication even today. But I believe that this means making things a little too easy for oneself.*"

> Conditions are admittedly such that we can always manage to make do in each concrete individual case without the two different aspects leading to different expectations as to the result of certain experiments. **We cannot, however, manage to make do with such old, familiar, and seemingly indispensable terms as "real" or "only possible"; we are never in a position to say what really is or what really happens, but we can only say what will be observed in any concrete individual case.** Will we have to be permanently satisfied with this...? **On principle, yes. On principle, there is nothing new in the postulate that in the end exact science should aim at nothing more than**

> **the description of what can really be observed. The question is only whether from now on we shall have to refrain from tying description to a clear hypothesis about the real nature of the world. There are many who wish to pronounce such abdication even today. But I believe that this means making things a little too easy for oneself.** 337

Schrödinger elaborates in the quote below on 'reality' and the cat in the box in a way which emphasizes the necessary role of individual observation and the murkiness not accounted for by our practical realities.

> If one has left this entire system to itself for an hour, one would say that the cat still lives if meanwhile no atom has decayed. The psi-function of the entire system would express this by having in it the living and dead cat (pardon the expression) mixed or smeared out in equal parts. 338

In Schrödinger's "Science and Humanism" he tells us that there is more to the *singulare tantum* of the subject "*perceiving and feeling subject*". In the quote below Schrödinger shows us his intellectual humility and ability to remain open about pressing questions without resorting to inherited dogmas.

> **I am born into an environment — I know not whence I came nor whither I go nor who I am.** This is my situation as yours, every single one of you. The fact that everyone always was in this same situation, and always will be, tells me nothing. **Our burning question as to the whence and whither — all we can ourselves observe about it is the present environment.** 339

I want to follow what I just wrote about to make sure my

intentions are clear. I have much admiration for Schrödinger. Schrödinger and his contemporaries were highly well-read about subjects most folks would never believe they even knew about. They were very philosophical and intellectually curious. It is hard to say what came first, their love for philosophy and history or their love for science. Whatever it was, their great contributions to science reflected their deep philosophical insights as well. They were willing to step outside the academics of their day and make bold assertions. There were plenty in their day who thought they were crackpots like the authors of the book "One Hundred Authors Against Einstein." Einstein was accused of subverting the scientific method and pushing a theory of relativity without testing it first. Charles Lane Poor, a highly esteemed astronomer and professor of celestial mechanics reportedly said after he first read about relativity, "I feel as if I had been wandering with Alice in Wonderland and had tea with the Mad Hatter." He authored numerous books attacking Einstein and general relativity including one named "Gravitation versus Relativity" where he stated,

> "The Relativity Theory, as announced by Einstein, shatters our fundamental ideas in regard to space and time, destroys the basis upon which has been built the entire edifice of modern science, and substitutes a nebulous conception of varying standards and shifting unrealities. And this radical, this destroying theory has been accepted as lightly and as easily as one accepts a correction to the estimated height of a mountain in Asia, or to the source of a river in equatorial Africa." 340

Many others in their field of physics and outside their field pelted them with hostile criticism and derision including religious leaders who were horrified with the notion of 'relativity' as it detracted from the absolute God. But all these innovators in quantum physics were men and women put their careers in

jeopardy to take a stand on what they believed was a questionable step away from their own educational backgrounds. Yet, with that being said, I simply want to see if we can step back and see how they were torn themselves about their findings. They were well aware that their findings were unconventional, but they also felt a need to find some common ground with their histories and science and philosophy. They authored books addressing their own well-informed philosophical conflicts. Einstein tried and failed to find a unified field theory of local variables for decades at the end of his life to reconcile his findings with his historical inclinations. In the comments I just made I hope the reader will not look at my critique so much as a dialectic but an attempt to show their own conflicts and deep questioning about what they were finding. In my own feeble philosophical journeys, I have also felt the tug of traditions and have found that being wrong is not nearly so bad as thinking I am right all the time and I have to defend it to the death. I have found that being wrong provides grounds for learning and change. Being right all the time means the journey has settled into dogma.

One more thing, our modernistic science background has taught us to be very wary about dogma and both religious and philosophical underpinnings. Scientists are acutely aware of the dangers of such undertakings. We have just seen how Schrödinger falls back at times into more positivistic inclinations with phrases like "*just the facts*" and "*collection of single data*" in which sense impressions reside and predominate. Yet both Schrödinger and Einstein understood the ramifications of how their findings impacted philosophy and even religion. They did not reflect some kind of purest empirical dogma although they were keenly aware of the problems associated with such musings. Earlier scientists such as Newton and Descartes were Christian and felt like their work strengthened their religious dogmas. And as we already saw, there was also a strain in alchemy and aether which gathered together Christianity and histories much older and more archaic than Christianity. What many of us have been left with in popular

culture is a fissure between scientific 'fact' based knowledge and myths of dogma and tradition. This is the undercurrent of modernism which still reigns supreme in strains of commonsense.

The modernistic separation between religious and philosophical inquiries and scientific inquiries has left many folks who are not aware of 20th century phenomenology and postmodernism in a binary opposition where sides must be taken, and no excess can be allowed. But 20th century science and philosophy have moved beyond all those relevancies of binary oppositions and have struck out into areas which are no longer content to rehash tired old paradigms of the past. Classic physics finds a place as a limited case of relativity given certain assumptions. Quantum physics has sought to find a place for relativity in quantum field theory. Likewise, phenomenology does not care to dispute the metaphysics of bygone eras but would rather look at how it is that humans are historical, how we carry centuries of histories around with us in the day-to-day certainties of our practical, daily lives. Phenomenology wants to understand how we live time and live space. It does not care about classical theories of clock time and linear space. Phenomenology as a contemporary of relativity wants to see how lived experience bends temporality and spatiality. Postmodernism wants to look beneath our valuations of truth and 'reality' into the quantum physics of valuations which punctures the fabric of truth and reason, the centrism of *logos*, of dominant narratives and how they symbiotically perpetuate themselves. If quantum physics teaches us anything, it is that phenomena are not the question, but phenomena bring us into question. Levinas wants to bring us face-to-face with radical alterities whose externalities, in my view in a spooky way like quantum physics, bring us to a chasm, a chaos, which are not totalized by our reason but require an answer, before even choice as responsibility.

Why does the Quantum Wave Function Work?

Albert Einstein:

"Spooky action at a distance" [341]

Niels Bohr:

"Those who are not shocked when they first come across quantum theory cannot possibly have understood it."

"The very nature of the quantum theory … forces us to regard the space-time coordination and the claim of causality, the union of which characterizes the classical theories, as complementary but exclusive features of the description, symbolizing the idealization of observation and description, respectively." [342]

Werner Heisenberg:

"I remember discussions with Bohr which went through many hours till very late at night and ended almost in despair; and when at the end of the discussion I went alone for a walk in the neighboring park I repeated to myself again and again the question: Can nature possibly be so absurd as it seemed to us in these atomic experiments?"

"Quantum theory provides us with a striking illustration of the fact that we can fully understand a connection though we can only speak of it in images and parables."

"[T]he atoms or elementary particles themselves are not real; they form a world of potentialities or possibilities rather than one of things or facts." [343]

Richard Feynman:

"In the world of the very small, where particle and wave aspects of reality are equally significant, things do not

> behave in any way that we can understand from our experience of the everyday world…all pictures are false, and there is no physical analogy we can make to understand what goes on inside atoms. Atoms behave like atoms, nothing else." [344]

Louis de Broglie:

> "Two seemingly incompatible conceptions can each represent an aspect of the truth … They may serve in turn to represent the facts without ever entering into direct conflict." [345]

Werner Heisenberg:

> "In atomic physics, we can never speak about nature without, at the same time, speaking about ourselves." [346]

Albert Einstein to Abraham Pais:

> "Do you really believe the moon is only there when you look at it?" [347]

If measuring something makes it happen, Einstein mused, does it mean that if we aren't measuring, things don't exist? Einstein was being facetious, but… like… maybe?

Below is a good analogy of what we are talking about when we think of the quantum wave function,

> You can think of the wave equation like Ella Enchanted's magical book (the film iteration works best for this analogy, but for the novel fans, it should work just as well). Ella's magical book keeps track of the world as it changes through time. Likewise, the wave function changes the probabilities of the different states of a particle through time. Ella can

> open the book and see the location of the mischievous fairy who cursed her. In quantum, we can measure the location of a particle. But, until a measurement is made, the wave function is in a state of superposition, where everything that is possible is occurring all at once. While the book is closed, anything that is possible is unfolding its pages, unread. Mathematically solving the wave function only reveals the probabilities of each possible state. It is akin to Ella having the book with her, but keeping it unopened. She knows there is some probability that the fairy is at a giant's wedding or maybe getting a ticket for flying while intoxicated (that part only happens in the movie). [348]

These quotes reflect both wonder and perplexity at the strange and fascinating world revealed by quantum mechanics.

The quantum wave function is probably the most successful breakthrough in the entire history of humanity. There is only one major but interesting problem – no one knows why it works including the original founder of the quantum wave function. Starting in 1900, Max Planck (1858-1947) postulated a relationship with a photon's energy 'E' and frequency 'f' which along with his most startling constant 'h' called the Planck constant became the formula $E = h/f$. In 1923, Louis de Broglie (1892-1987) was the first to suggest that wavelength 'λ' was related to momentum 'p' in the formula $\lambda = h/p$. This is viewed as the start of quantum mechanics. These equations were the first to demonstrate what we now call the wave-particle duality. In 1926, Erwin Schrödinger (1887-1961) published the famous wave equation or what we now think of as the quantum wave equation. Schrödinger himself initially thought of his discovery as purely mathematical. Later he came to believe that it was physical but he, like many others after him to the present day, did not know and still do not know what to make out of it. [349] In 1944, Schrödinger published a book entitled, "What is Life". In this book Schrödinger is wrestling with the chaos

he sees in the complexities of quantum physics and how life can emerge from this chaos. He thinks of this chaos as ‘order-from-disorder.

> In Chapter I, Schrödinger explains that most physical laws on a large scale are due to chaos on a small scale. He calls this principle "order-from-disorder". 350

However, in Schrödinger’s wave equation there is an essential assumption that physicists call unitarity. Schrödinger’s wave equation is remarkable in that it found that while in superposition, the wave state, changes can occur which are predictable and deterministic. The reason for this is no matter what changes occur in superposition the sum of the squares of the wave amplitudes through wave transitions in superposition always reflect probabilities for finding a particular result. Not only that, if you have complete information about all the interfering waves which may be transitioning while in superposition, the sum of the squares of the amplitudes of all possible outcomes will always sum up to one. This is called unitarity. We saw this formula earlier. In essence it means the result of the wave function must exist. There must be an observable like energy, momentum, or position which can exist or collapse into a value which exists.

$$1 = \sum_{x=-\infty}^{+\infty} |\psi(x)|^2$$

351

Unitarity ensures that probabilities are preserved during quantum evolution, and it’s considered a fundamental postulate of quantum mechanics. Fundamentally, unitarity depends on the

reversibility while in a state of quantum superposition. If a quantum process can unfold while in superposition, it can also in the theory of unitarity go the other way and fold back together when reversing superposition states. While in superposition states can change over time. However, this change over time is always constant with regard to the total probability of all possible outcomes as the square of the wave function while in superposition. In classical physics and relativity time is reversible like rewinding a recorded video. In quantum physics unitarity is reversible while in superposition (at least in theory). Unitarity establishes a provisional order in the quantum wave function. Unitarity in the wave function is still a main assumption in working quantum physics but since the beginning this assumption has presented some problems. New studies coming out now are taking fresh looks at the reversibility of time in the superposition of the quantum wave function. Certainly, there is a preponderance of evidence that there is some form of orderliness and predictability in superposition which is dependent on reversibility. For now, let's follow Schrödinger's argument a little further.

For Schrödinger, the real world, the observed world involves aperiodic behavior and statistical methods. Aperiodic behavior means irregular occurrence, not periodic, without an exact repeating pattern. Schrödinger recognized aperiodic behavior in his 1944 book entitled "What is Life." He cites examples of aperiodic crystals and cell chromosome fiber.

Aperiodic crystals do not have symmetry in three dimensions but nevertheless exhibit a three-dimensional long-range order. In higher dimensions than three their periodicity becomes apparent. [352] As a side, string theory also shows us mathematically how certain asymmetries we see in the behavior of point particles can be explained by higher dimensions. Schrödinger makes a case in "What is Life" that statistical methods may underlie all of our classical theories of an ordered, absolute universe, a 'real' world. In "What is Life" Schrödinger even contemplates chaos, what he calls "order-

from-disorder", "*which is actually followed in Nature and which alone conveys an understanding of the great line of natural events, in the first place of their irreversibility.*"

> The orderliness encountered in the unfolding of life springs from a different source. It appears that there are two different 'mechanisms' by which orderly events can be produced: the 'statistical mechanism' which produces order from disorder and the new one [I take this to mean 'new' in terms of human history], producing order from order. To the unprejudiced mind the second principle appears to be much simpler, much more plausible. No doubt it is. That is why physicists were so proud to have fallen in with the other one, the 'order-from-disorder' principle, which is **actually** followed in Nature and which alone conveys an understanding of the great line of natural events, in the first place of their **irreversibility**. 353

Schrödinger seems to look at order as engendered by disorder on the scales of atoms and quanta which requires statistical methods. Order emerges from extreme complexity, chance, and disorder. Disorder shows itself as statistics in nature, which is aperiodic, nonrepetitive behavior, and "*the first place of their irreversibility*". He seems to criticize the history of "*order from order*".

> The unfolding of events in the life cycle of an organism exhibits an admirable regularity and
>
> orderliness, unrivalled by anything we meet with in inanimate matter. We find it controlled by a
>
> supremely well-ordered group of atoms, which represent only a very small fraction of the sum
>
> total in every cell. Moreover, from the view we have formed of the mechanism of mutation we
>
> conclude that the dislocation of just a few atoms within

the group of 'governing atoms' of the

germ cell suffices to bring about a well-defined change in the large-scale hereditary

characteristics of the organism. These facts are easily the most interesting that science has

revealed in our day. We may be inclined to find organism's astonishing gift of concentrating a

'stream of order' on itself and thus escaping that the decay into atomic **chaos** -of 'drinking

orderliness' from a suitable environment -seems to be connected with the presence of the

'aperiodic solids', the chromosome molecules, which doubtless represent the highest degree of

well-ordered atomic association we know of - much higher than the ordinary periodic crystal -

in virtue of the individual role every atom and every radical is playing here. To put it briefly,

we witness the event that existing order displays the power of maintaining itself and of producing

orderly events. That sounds plausible enough, though in finding it plausible we, no doubt, draw

on experience concerning social organization and other events which involve the activity of

organisms. And so it might seem that something like a vicious circle is implied…

But whenever we do, we find complete irregularity, co-operating to produce regularity

only on the average. 354

This argument has held up well in decades after Schrödinger. In contradistinction to the ‘real’ world Schrödinger sees whatever we want to call the wave equation as continuous and deterministic. But from the perspective of the wave equation unitarity is of major importance in working physics. However, there have been and will

continue to be problems and work on solutions to some of the issues with unitarity.

Unitarity, Reversibility, and Isometry

Can something as relatively simple as the double-slit experiment be reversed? Can we go from an interference pattern on a screen to photons coming out of a laser? The answer is no. It has not been done and not because it has not been tried. In order to reverse the double-slit experiment we would have to get information about what slit the photon went through. Then, we could work backwards to the slit to get back to the photon laser. There is only one impossible catch-22 situation in this case. There are two reasons for this,

1. 'Tagging' the photon to determine which slit it went through would mean measuring it. But according to Heisenberg's uncertainty principle, this information cannot be known in principle. I hesitate to use the words essentially, fundamentally, absolutely, etc. because all these kinds of terms interfere with what is meant by the uncertainty principle. What is meant underlies the words essentially, fundamentally, absolutely without setting a new essentiality, fundamentality, or absoluteness. Neither does it negate essentiality, fundamentality, or absoluteness. Heisenberg's uncertainty principle is oblivious to these classically constrained ideas. It exceeds them heedless of their historically derived necessities.
2. If we try to measure the path the particle took through the slits, we effectively put a photon detector on the slit. And we know that doing that will alter the experiment. It would collapse the superposition vis-à-vis the observer effect. This would alter the original forward direction of the experiment. We would get the single-slit particle

> diffraction pattern at the slit. Perhaps if we had information, the complete history, available to us we could infer in the reverse direction without measurement. But that history is shown by Heisenberg's uncertainty principle to be forever unavailable to us. We are in a vicious circle for both of these reasons. [355]

In classical mechanics, we often think of a system following a single, well-defined trajectory (like the path of a planet around the Sun). However, in quantum mechanics, particles exhibit wave-like behavior, and their trajectories are inherently uncertain. Richard Feynman's (1918-1988) path integral formulation replaces the idea of a single classical trajectory with a sum over all possible quantum-mechanically allowed paths that a particle could take from an initial state to a final state. Instead of focusing on one specific path, we consider an integral over all possible paths connecting the initial and final states. Each path contributes in a weighted fashion to the overall quantum amplitude of the system. This integral is called the path integral because it involves integrating over an infinite-dimensional space of paths. The path integral allows us to compute quantum amplitudes, which are complex numbers representing the probability of transitioning from one state to another. By summing up contributions from all paths, we obtain the total amplitude for a given process.

These paths would be infinite as some might traverse around the universe before returning. We know that entanglement is oblivious to our notions of time and space, cause and effect. Uncertainty is not provisional until we learn more. It is impossible unless perhaps it would be LaPlace's demon but let's not wax metaphysical. The bottom line is that we must give up on being able to reverse even the simplest experiment much less the vast complexities beyond that. Simply put, unitarity as reversibility is certainly possible in classical physics and even classical relativity but underneath that veneer in quantum physics there is an abyss which will never be

bridged. For the purposes of this discussion, this abyss is superposition.

The wave function is bizarre in that it can describe multiple entangled systems as well as particles in superposition to a certain level of complexity. As Schrödinger told us, it is statistical or as Heisenberg said it, uncertain. The unnerving thing about the wave function is that in some indeterminate way, it can give us probabilities about possible outcomes given enough information about the histories, the information, which went into the superposition state. When two or more systems or particles become entangled, their wave functions become intertwined. Measuring one particle instantly affects the state of the other, regardless of the distance between them. If we have sufficient knowledge of, know the history of, the eigenstates prior to observation while in the superposition state, the wave function can give us probability densities defined by the squares of the amplitudes for what we will observe on wave function collapse (or information updating) resulting in a classical state of a single observable eigenstate. However, by virtue of collapse (or information updating) into a classical state information has leaked out into the environment. This is sort of like an increase in entropy. However, entropy is not defined for single particles in quantum physics. What really is happening is that in the collapse another microstate is introduced which is a mixture of classical states that cannot be recovered. The transition prior to wave function collapse is fundamentally reversible in theory. Given an initial wave function, one can predict its state at some future time, and in principle, run the evolution backward to recover the prior state. Even after collapse, given LaPlace's demon where all information is known, classical collapse after quantum superposition would not be 'classical' at all. It would simply become a new addition to superposition, to the wave function. Effectively, there would be no 'classical' at all only pure wave function which never collapsed or branched. However, for practical purposes, after collapse or branching irreversibility is

impossible due to the complexity of the environment. The environment, being a large and intricate quantum system, makes it infeasible to reverse their interaction completely.

I will discuss entanglement more soon but for now entangled particles can exist in a superposition of states. For example, consider two entangled electrons with opposite spins. Their combined state is entangled, and their spins are correlated. This means that they act in tandem in the wave state as if they were one particle. Now, when these entangled particles interact with their surroundings (such as through measurement or scattering), their entanglement spreads to the environment. The scattered photons or other particles become entangled with the superposed target body. As a result of this interaction, the phase coherence (which is essential for quantum behavior) becomes delocalized from the target body to the entire system. The interference pattern that arises from the superposition becomes unobservable. Essentially, the system loses its quantum behavior and appears to behave classically. The entangled particles no longer maintain their original superposition state in an entangled state. Instead, they decohere into a state where only one of the possible coherent states exists. This collapse is irreversible and leads to classical behavior.

Decoherence does not mean that somehow it reverses the collapse; it merely provides a framework for apparent collapse as quantum information spreads into the environment. Decoherence refers to how quantum systems lose their coherence when interacting with their surroundings (environment). While decoherence explains why we observe classical behavior at macroscopic scales, it doesn't reverse wave function collapse. The combined system (quantum system + environment) still obeys the Schrödinger equation throughout apparent collapse, but it doesn't restore superpositions. Reversibility in classical physics doesn't directly map to quantum collapse. While classical processes can be reversed deterministically in superposition, quantum collapse is inherently probabilistic. The measurement or observer process

introduces irreversibility due to entanglement with the measuring apparatus. Attempting to reverse a collapsed quantum state would violate unitarity. Unitarity (total probability conservation). However, superposition remains distinct from classical collapse. Superposition refers to the simultaneous existence of multiple states until measured, while collapse involves transitioning to a specific state upon measurement. Superposition and collapse are distinct features of quantum systems that defy classical intuition. Reversing wave function collapse would require manipulating information that has already leaked into the environment—an incredibly complex if not impossible task.

The collapse into classical observables implies locality. Locality in classical physics (with the exception of classical systems with friction) and even general relativity is reversible. But quantum physics has made clear to us that there are real problems with reversibility going from the classical domain of measured states in a classical local environment to superposition in a nonlocal environment. Locality implies information which has leaked or become integral with the entire environment. In order to restore the superposition which is nonlocal of the previously entangled systems in superposition it would require not just the prior entangled systems but the entire environment which has now become part of the classically local environment. Additionally, since entropy has a direction towards more entropy reversibility would also require an environmental recapture of a state which previously had less entropy. This would be highly complex and far reaching. Effectively, the 'environment' now implies the entire universe. Reversibility allows us to predict future states from past states, assuming complete knowledge of the current state (akin to Laplace's famous demon). It would take LaPlace's demon to reverse entropic and environmental classical states to quantum states of superposition. Rather than believe this would be practically impossible but in theory possible, why not think about it in a different way. Perhaps in the same way that classic physics is now

understood as a limited case of quantum physics, could we think of reversibility as a limited case of classical collapse without extending it back into superposition?

As we will see locality is a limited case of entangled non-locality. If spacetime emerged from nonlocality, chaotic entangled information, in the singularity of the Big Bang, this spooky kind of entangled information is not the exception now, it is the rule. Schrödinger himself called entanglement not "***one [property of quantum mechanics] but rather the characteristic trait of quantum mechanics, the one that enforces its entire departure from classical lines of thought***". [356] So, requiring LaPlace's demon or God to put the universal genie back in the singularity of the Big Bang bottle seems to me to make one major assumption – that the chaos of the Big Bang singularity is not really chaos but simply infinitely complex coded information which could only deterministically unfold and refold from some metaphysical, primordial order. But why jump through all these hoops?

As we will see later, major breakthroughs at work in quantum gravity are revolutionizing quantum physics. Quantum gravity shows us a picture of the early universe and our current universe where reversibility seems to vanish in expanding degrees of freedom or informational complexity in the expanding universe. It seems that running the universe in reverse could not create emergence and novelty which we see looking forward but create infinities and infinitesimals (and perhaps the absolutes of classic physics, philosophy, and religion). Here is a thought experiment about how unitarity might be problematic,

> Imagine taking the current state of the universe, said Giddings, and adding "one innocuous photon" — perhaps lodged in newly created space halfway between here and the Andromeda galaxy. Unitarity insists that we must be able to calculate what this universe looked like in the past, unswiveling its quantum state as much as we wish.

> But rewinding the state of the universe plus an extra photon creates a glitch. Going into the past, the universe gets smaller, and the wavelength of photons will shrink too. In our real universe, this isn't a problem: A photon shrinks only until the moment of its creation through some subatomic process; the reversal of that process will make it disappear. But the extra photon wasn't created by that special process, so instead of disappearing when you turn back time, its wavelength will eventually get impossibly small, concentrating its energy so greatly that the photon collapses into a black hole. This creates a paradox, absurdly implying that — in this fictional, expanding universe — microscopic black holes convert into photons. The thought experiment suggests that a naïve mashup of unitarity and cosmic expansion doesn't work. 357

And rewinding back cosmologically does not account for emergence and novelty from more informational complexity in the universe's expansion where the local limit of entropic complexity is exceeded generating new degrees of freedom. However, relativity rewinds us back to infinites and infinitesimals as if the added complexity of informational entropy offered no more degrees of freedom and only more of the same. We know that information cannot be lost but this does not mean that new degrees of informational complexities cannot evolve. In relativity, rewinding time is preserved by singularities (the Big Bang) which are infinitesimal (and impossible in the 'real' world). By virtue of this, spacetime is symmetric and continuous. Events are continuous and deterministic. Every cause corresponds to a specific, local effect (remember Einstein's failed search for the local variables of a unified field theory). Relativity works forward and backward in time. In quantum mechanics quanta result in asymmetry and discontinuities. Spacetime emerges as quantized entangled fields. The idea of quantum spacetime emerged early in quantum theory as

a means to eliminate infinities from quantum field theory. Spacetime is not infinite but breaks down at Planck scales. To be fair, there are continuous functions such as positions and momenta of particles. The unitary function in Schrödinger's time-dependent wave equation works forward in time but not the same way as you would expect in reverse. The time reversal operator in the wave function is antiunitary. A unitary operator is a kind of mathematical transformation which preserves orientations and movements, for example, in space like translations (like moving in a straight line) and rotations. Mathematical matrix inversion plays a role in reversibility through unitary transformations. However, antiunitary operators do not conserve orientation as for example how a mirror reverses left-right orientations but not up-down orientations.

I will get into this later, but locality seems to require a certain amount of symmetry and reversibility. Below are comments from a recent article entitled, "*Physicists shed light on a different kind of chaos*."

> Physicists at UC Santa Barbara, the University of Maryland, and the University of Washington have found an answer to the longstanding physics question: How do interparticle interactions affect dynamical localization?...
>
> So, what emerges when you introduce interaction in a disordered, chaotic quantum system? A "weird quantum state," according to Weld. "It's a state which is anomalous, with properties which in some sense lie between the classical prediction and the non-interacting quantum prediction."…
>
> Weld's team used a technique called an "echo" in which the kinetic evolution is run forward and then backward to directly measure the way in which interactions destroy time reversibility. This destruction of time reversibility is a key signature of quantum chaos.
>
> "Another way to think about this is to ask: How much memory of the initial state does the system have after some

time?" said co-author Roshan Sajjad, a graduate student researcher on the lithium team. In the absence of any perturbations such as stray light or gas collisions, he explained, the system should be able to return to its initial state if the physics is run backward. "In our experiment, we reverse time by reversing the phase of the kicks, 'undoing' the effects of the first normal set of kicks," he said. "Part of our fascination was that different theories had predicted different behaviors on the outcome of this type of interacting setup, but no one had ever done the experiment."

"The rough idea of chaos is that even though the laws of motion are time-reversible, a many-particle system can be so complicated and sensitive to perturbations that it is practically impossible to return to its initial state," said lead author Alec Cao. The twist was that in an effectively disordered (localized) state, the interactions broke the localization somewhat, even as the system lost its capacity to be time-reversed, he explained

"Naively, you'd expect interactions to ruin time-reversal, but we saw something more interesting: A little bit of interaction actually helps," Sajjad added. "This was one of the more surprising results of this work." [358]

The article goes on to suggest that reversibility may be a limited case of something called isometry. In mathematics, isometry refers to a transformation that preserves distances between points in a metric space. Specifically:

- Given a metric space (which assigns distances between elements), an isometry is a transformation that maps elements to the same or another metric space.
- The key property of an isometry is that the distance between the image elements in the new metric space remains equal to the distance between the original

elements in the original metric space.
- Essentially, isometries preserve the metric structure of space. 359

Quantum isometry has a different spin:

- In quantum mechanics, the concept of isometry also arises, but it's related to preserving inner products, norms, and distances in the context of quantum states.
- Consider a quantum channel (a map that transforms quantum states). If this map preserves inner products (i.e., the norm of a state remains invariant), it is considered an isometry.
- Mathematically this would be displayed as, if $|\Psi\rangle = J|\psi\rangle$ and $|\Phi\rangle = J|\varphi\rangle$, where J is the quantum channel, then J is an isometry because it preserves inner products and, consequently, the norm and the metric based on the norm.
- So, in quantum mechanics, isometries play a role in preserving certain properties of quantum states. 360

The bottom line here is that unitarity would be preserved in isometry at least the same way it is preserved currently. However, it would not preclude expansions, novelty, and emergence in higher orders of complexity thought of as new degrees of freedom. Visually, a simple, analogical way to think about this is as multiple continuously added dimensions curled up as Planck sized dimensions. This seems to work with the arrow of time as entropy and the second law of thermodynamics.

> The second law of thermodynamics is a physical law based on universal empirical observation concerning heat and energy interconversions. A simple statement of the law is that heat always flows spontaneously from hotter to colder

> regions of matter (or 'downhill' in terms of the temperature gradient). Another statement is: "Not all heat can be converted into work in a cyclic process." The second law of thermodynamics establishes the concept of entropy as a physical property of a thermodynamic system. [361]

Also, because of universal expansion and entropy information complexity grows. But informational complexity reaches a limit set by the volume of space. You cannot put an infinite amount of information into a finite volume of space. When entropy creates information complexity it hits this limit. But that does not stop the process of increasing informational complexity according to isometry. The volume of the universe is expanding meaning that informational complexities can grow new degrees of freedom. New exotic properties, perhaps dark matter, etc. Everything will still look exactly the same as if everything in the universe including you doubled in size when you blinked your eyes but how would you know? It all looks and acts the same, but it is different. We may never 'see' these new degrees of freedom, but we do see emergence and novelty.

As discussed earlier, working quantum physicists have traditionally tailored their work to wave function collapse or better information branching. Susskind tells us they know that it is "*obvious that the Copenhagen interpretation cannot be the last word.*" because it is obvious because the universe is much more intricate by being filled with subsystems in which any one system can be in the role of the observer. He goes on to tell us that any that there is no place in the laws of quantum mechanics for this kind of literal interpretation of wave function collapse. Why? Because the universe evolves unitarily and becomes increasingly complex. I will repeat his quote here,

> Standard quantum mechanics— Copenhagen quantum mechanics—is set up in a way that requires a single external

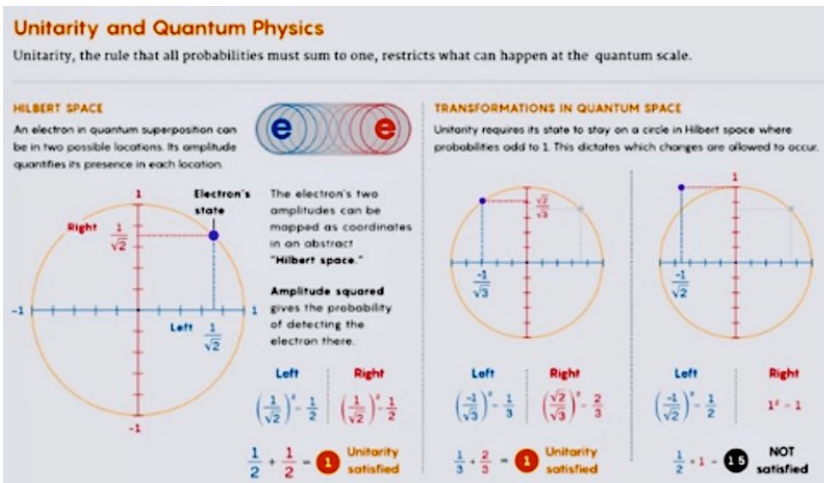
observer, one who is not part of the system. He, she, or it interacts occasionally with the system through a process called measurement, and in so doing collapses the wave function, throwing away all branches other than the one observed. In this view observations are irreversible events which cannot be undone. The method works well in practice but only because reversing a measurement is generally too complex a process to ever be of practical importance.

It is obvious that the Copenhagen Interpretation cannot be the last word. The universe is filled with subsystems, any one of which can play the role of observer. There is no place in the laws of quantum mechanics for wave function collapse; the only thing that happens is that the overall wave function evolves unitarily and becomes more and more entangled. The universe is an immensely complicated network of entangled subsystems, and only in some approximation can we single out a particular subsystem as THE OBSERVER. 362

I want to make one remark at this point about unitarity in the previous quote. In Schrödinger's wave equation unitary evolving states are a very important concept.

Unitarity, as the principle is called, says that something always happens. When particles interact, the probability of all possible outcomes must sum to 100%. Unitarity severely limits how atoms and subatomic particles might evolve from moment to moment. It also ensures that change is a two-way street: Any imaginable event at the quantum scale can be undone, at least on paper. These requirements have long guided physicists as they derive valid quantum formulas. "It's a very restrictive condition, even though it might seem a little bit trivial at first glance," said Yonatan Kahn, an assistant professor at the University of Illinois. 363

I want to remake one note on the concept of unitarity here. Unitarity means a process is reversible. Quantum computing is built on this assumption otherwise, for one, there would be no way to save and recall information. Schrödinger's wave equation depends on probabilities based on the square of amplitudes. Below is a diagram depicting how unitarity is not satisfied with transformations in space. This shows antiunitarity might violate transformations in space making reversibility problematic. If this diagram is too confusing, keep reading. I have an easier explanation below.


Unitarity and Quantum Physics
Unitarity, the rule that all probabilities must sum to one, restricts what can happen at the quantum scale.
HILBERT SPACE
An electron in quantum superposition can be in two possible locations. Its amplitude quantifies its presence in each location.
Electron's state
Right
Left
The electron's two amplitudes can be mapped as coordinates in an abstract "Hilbert space."
Amplitude squared gives the probability of detecting the electron there.
Left
Right
Unitarity satisfied
TRANSFORMATIONS IN QUANTUM SPACE
Unitarity requires its state to stay on a circle in Hilbert space where probabilities add to 1. This dictates which changes are allowed to occur.
Unitarity satisfied
NOT satisfied

What antiunitary boils down to is this, imagine we are in an antiunitary world. Certain, fundamental physical processes would behave very differently. Particles might exhibit exotic behaviors. Symmetries would show themselves in unexpected and bizarre ways perhaps leading to novel phenomenon. If this is too much for you, think of Lewis Carroll. He was a mathematician, but he died in 1898 so he would have been aware of some of the early mathematical beginnings of quantum physics. In any case, here are

some intriguing connections which seem to me to indicate an intuitive (or shall I say counterintuitive) approach to how an antiunitary world might look:

- Quantum Cheshire Cat Effect: In his 1865 classic, Alice in Wonderland, Carroll introduced the mysterious Cheshire Cat, which could vanish while leaving its grin behind. This whimsical character has captured physicists' attention, leading to discussions about whether an object can be separated from its properties. 365 Could the Cheshire Cat have certain symmetry properties reversed with only his grin to tell the tale?
- Mathematicians have turned to Carroll's work to simplify calculations used in particle physics. His mathematical ideas have found applications in various scientific domains. 366
- While not a quantum physicist per se, Carroll's imaginative thinking and exploration of paradoxes resonate with the spirit of quantum theory. His ability to play with logic and fantasy aligns with the curious and counterintuitive nature of quantum phenomena. 367

The antiunitary world may look like "Alice in Wonderland" but for quantum physicists time reversibility would still be symmetrical in that world making the quantum wave function 'time reversible'. This is probably how quantum physics got its reputation for going against commonsense. In any case, this only adds mystery and intrigue to the quantum wave function. It also further justifies my use of the phrase 'radical externality' which this book is intended to familiarize ourselves with.

Certainly, there is a sense in which unitarity, the ability to go forward and backward in time without losing any information (maybe only losing our sanity) is an important function of the quantum wave function. Practically, it has never been a question of

whether reversibility could ever be realized for complex quantum systems. The difficulties involved in realizing reversibility in complex quantum systems make testing the hypothesis practically impossible. But locally and for less complex systems the unitary operator is important for time evolution which greatly simplifies the mathematics required by what is called the Hamilton operator.

The assumption is that "*amplitudes never change in a way that disrupts the fixed sum of their squares. In the 1920s, for instance, this unitarity requirement guided the British physicist Paul Dirac to discover an equation that implied the existence of antimatter. "I was not interested in considering any theory which would not fit in with my darling," Dirac wrote, referring to unitarity.*" [368] Cosmology tells us we can rewind time. But there is something about rewinding time which does not make sense.

> But rewinding the state of the universe plus an extra photon creates a glitch. Going into the past, the universe gets smaller, and the wavelength of photons will shrink too. In our real universe, this isn't a problem: A photon shrinks only until the moment of its creation through some subatomic process; the reversal of that process will make it disappear. But the extra photon wasn't created by that special process, so instead of disappearing when you turn back time, its wavelength will eventually get impossibly small, concentrating its energy so greatly that the photon collapses into a black hole. This creates a paradox, absurdly implying that — in this fictional, expanding universe — microscopic black holes convert into photons. The thought experiment suggests that a naïve mashup of unitarity and cosmic expansion doesn't work. [369]

This comment about the impossibility of rewinding the clock is very important to my discussion. In general relativity rewinding the clock is simply a matter of finding smaller and smaller particles,

imposing the mathematics of infinitesimals into the reverse direction. Unitarity in the wave equation assumes this can be done. However, here is where quantum physics and general relativity begin to diverge. Quantum physics tells us that the wave function is not continuous. Uncertainty, emergence and novelty are the rule rather than the exception. Photons can pop into and out of existence when we impose temporality in the forward direction. As we will see shortly, when the universe expands, new degrees of freedom are created which did not exist before. New degrees of freedom is another way of saying that the complexity of the universe increases past previously established limits. This also has radical implications on the classical idea of temporality. The idea of the soul as eternal and many other religious and metaphysical assumptions is based on the idea of infinites and infinitesimals. The mathematical idea of asymptotic limits where the limit can be approached but never reached, resulting in infinitesimals, is an idea easily assimilated to the classical idea of temporality as eternal. However, quantum physics tells us that physicality itself is branching from the spooky wave function. The wave function is not physical, and neither is it the 'not' of physical. It is an excess, a gaping void, chaos. Spacetime and all our provincial ideas of existence, being, essence, etc. emerge from the radical externality of the quantum wave function. Complexity whether looking forward into the expanding universe or backwards towards the Big Bang are all engulfed by the spooky void, the chaos of wave function complexity. All temporalization is a limited case of chaos past the point of complexity which emerges and returns to the radical exteriority of the universal[370] quantum wave function. Let's explore this more with alternates which support a limited, semiclassical unitarity in the wave function.

But much of the work in quantum gravity and information complexity is going counter to the veracity of temporal reversibility. One possible way out of this quagmire would be to find a way to make unitarity a limited case of a more all-encompassing theory

just as quantum mechanics was able to achieve with classical physics and to a large degree with general relativity. One such idea is called isometry.

> two quantum gravity theorists may have found a way to loosen unitarity's buckles to better fit our growing cosmos. Andrew Strominger and Jordan Cotler of Harvard University argue that a more relaxed principle called isometry can accommodate an expanding universe while still satisfying the stringent requirements that first made unitary a guiding light…
>
> "You don't need unitarity," said Strominger. "Unitarity is too strong a condition."
>
> While many physicists are receptive to the isometry proposal — some have even come to similar conclusions independently — opinions vary as to whether the update is too radical or not radical enough. 371

Is the wave function real or is it mathematical or in philosophy we think ontological or epistemological (to be discussed later). We will see there are many interpretations all of which are necessarily philosophical. As we will see, many of the greatest thinkers in quantum physics were themselves excellent philosophers and even published many books and papers strictly on the philosophical implications of the findings. The quantum wave equation and Einstein's "spooky-action-at-a-distance" which we now call quantum entanglement is truly an enigma that, once one understands it, disrupts us, and makes us uncomfortable. We have no easy way to incorporate it into our language, history, and culture. It asks us to step away from our casual certainties and peer into an abyss where easy answers do not exist (and neither do the 'not exist). Perhaps below, the world of quantum physics, should come with Boethius' warning label to Orpheus…

He shall not turn his gaze.'

Who can give lovers laws?
Love is a greater law unto itself.
Woe! By the very boundaries of Night
Orpheus, his Eurydice
Saw, lost, and killed.
To you this tale refers,
Who seek to lead your mind
Into the upper day;
For he who overcome should turn back his gaze
Towards the Tartarean cave,
Whatever excellence he takes with him
He loses when he looks on those below.
—Boethius, Consolation of Philosophy 3.52 372

Bohr tells us that if we are not 'shocked' by quantum theory we have not understood it. The quantum wave function is probably what Zen talks about when it gives a koan to a student telling the student, "What is the sound of one hand clapping?" and asks the student to dwell on it and come back when an answer is found. If the student is wise, he or she never returns. From personal experience, I can tell you the wave function is a bit like a tar baby that begs one for a way of escape only to find oneself more mired in it. On one hand, I think of Everett and how everything is going along smoothly and obliviously (like the unconscious in superposition) and then the wave function emerges (like consciousness) but in neither 'idea' or 'reality', in some hazy middle, exteriority updating information about some new world or universe you just stepping into (past, present, and future) for the first time… only to find that narrative emerges finding some fabled way to bridge the gap between the previous world or universe giving the novelty of this new universe the illusion of the same. On the other hand, this extremely altered universe is not of my own making but somehow participates in and requires a 'us'. There is only one judgement I can find which I can securely derive from all this: there is radical alterity which looks us in the face dispelling all

our historic narratives and simply asks us to behold and wonder as debt and obligation.

The Physics Time Problem

In quantum mechanics, the concept of time is still a topic of debate. There is a conceptual conflict between general relativity and quantum mechanics in that quantum mechanics regards the flow of time as universal and absolute, whereas general relativity regards the flow of time as malleable and relative. The problem of time raises the question of what time really is in a physical sense and whether it is truly a real, distinct phenomenon. In classical mechanics, time is treated as a classical background parameter, external to the system itself. This special role is seen in the standard formulation of quantum mechanics. It is regarded as part of a priori given classical background with a well-defined value. However, in general relativity, time is no longer a background parameter, but must be considered on equal footing with space, and time and space evolve together as spacetime. The quantum concept of time first emerged from early research on quantum gravity, in particular from the work of Bryce DeWitt in the 1960s.

> "Other times are just special cases of other universes." 373

In other words, time is an entanglement phenomenon, which places all equal clock readings (of correctly prepared clocks – or of any objects usable as clocks) into the same history. In 1983 Don Page and William Wootters proposed solutions to the problem of time include the conditional probabilities interpretation, which consists of promoting all variables to quantum operators, one of them as a clock, and asking conditional probability questions with respect to other variables. In 2013, Ekaterina Moreva, together with Giorgio Brida, Marco Gramegna, Vittorio Giovannetti, Lorenzo Maccone, and Marco Genovese performed the first experimental test

of Page and Wootters' ideas. They confirmed that time is an emergent phenomenon for internal observers but absent for external observers of the universe just as the Wheeler–DeWitt equation predicts. Effectively, this tells us that clocks are a result of the observer effect.

> In quantum mechanics, time is understood as an external ('classical') concept. So it is assumed, as in classical physics, to exist as a controller of all motion — either as absolute time or in the form of proper times defined by a classical spacetime metric. 374

The clock we use to observe and measure collapses, branches, falls from the quantum wave function into classicism. Interestingly, it is also already in the simultaneity of the wave function which 'sees' no collapse, branch, or fall at all that we can only see as classicism. 375 Let's try to break this down more.

The problem of time is a conceptual conflict between general relativity and quantum mechanics. Quantum mechanics uses time as an independent variable in experimentation but has no physical account of how time comes about either as a fundamental phenomenon or as emergent phenomenon. While general relativity explains the dynamics of spacetime beautifully, neither does it have a physical account of how time or space comes about either as fundamental phenomena or as emergent phenomena. General relativity simply assumes spacetime exists. Even general relativity does not regard time as universal and absolute in the classic sense of universal and absolute meaning steady ticks of what we think as clock time being the same all over spacetime. General relativity regards the flow of time as malleable and relative. Often it is said that quantum mechanics regards the flow of time as universal and absolute referring to the unitarity assumption of the quantum wave function. But what physicists mean by 'universal and absolute' is not what classical philosophy means by 'universal and absolute'.

Physics simply regards time as a necessary component external to the behavior of quanta. This problem raises the question of what time really is in a physical sense and whether it is truly a real, distinct phenomenon. Many quantum physicists simply believe that time is a useful fiction. However, time as we experience it, as lived time, feels like it has a direction to it – from the past to the future. There are other explanations for how we feel time from biological, the change of events, and entropy which have nothing to do with a 'reality' called 'time'. All these ideas will be discussed throughout the course of this book. In this section, I want to look at these issues in more detail.

In classical mechanics, time is treated as a classical background parameter, external to the system itself. However, within general relativity, time is no longer a background parameter, but must be considered on equal footing with space, and time and space evolve together as spacetime. The quantum concept of time first emerged from early research on quantum gravity, from the work of Bryce DeWitt in the 1960s. Proposed solutions to the problem of time include the conditional probabilities interpretation, which consists in promoting all variables to quantum operators, one of them as a clock, and asking conditional probability questions with respect to other variables. 376

The wave function operator is a mathematical operator that acts on the wave function of a quantum mechanical system. It is used to calculate the probability of finding a particle in a particular state. The wave function operator does not have a time operator per se, but the time evolution of the wave function can be described by the Schrödinger equation. The Schrödinger equation describes how the wave function of a quantum mechanical system changes over time. It is a partial differential equation that relates the time derivative of the wave function to its spatial derivatives and the potential energy of the system. The wave function operator does not have a time operator, but the time evolution of the wave function can be described by the Schrödinger equation. 377 The time evolution of

the wave function is a useful tool but does not describe quantum phenomenon itself which, for example, gives rise to time evolution.

As mentioned, generally in physics quantum theory borrows the classical concept of time as ‘universal’ and ‘absolute’. By using classical notions of time, quantum physics understands well that for the most part this is simply a stand-in for something we have no real physical basis of understanding. General relativity uses these classical notions quite eloquently but very differently than the classical notions of time as ‘universal’ and ‘absolute’. Relativity tells us that classical time and space work fine at speeds much less than the speed of light but near the speed of light both time and space change, are deformed, quite different from our commonsense notions of time. General relativity understands space and time as two different ways of looking at the same phenomenon. This is much like the wave/particle duality we see in quantum physics. Yet, general relativity makes no attempt to understand what exactly time and space are. However, it works incredibly well at describing how it works. Time and space cannot be derived from a physical fundamental phenomenon property in relativity. Continuous time and space are simply assumed.

Quantum physics is the science which wants to understand how phenomena such as how what we think of time and space are grown from elementary particles, from where they sprout. Time in much of working, non-relativistic quantum physics is a utilitarian tool for making distinctions in quantum states. In relativistic quantum field theory where gravity is an issue, general relativity’s approach to time is useful. There is a theoretical area of quantum physics which gives an account of time from quanta. It is called the evolving or crystallizing block universe. This will be discussed in more detail later.

Regarding nonrelativistic, working quantum physics, quantum systems are understood as stochastic, statistical measurements of ‘jumps’ between quantum states.

> Historically, the dynamics of quantum systems seemed to consist of individually undetermined stochastic 'quantum jumps' between otherwise 'stationary' states (energy eigenstates) – see [2] for an early review of the formalism and the attempt of an interpretation. Such stochastic events are observed in quantum measurements, in particular. For this reason, von Neumann [3] referred to the time-dependent →Schrödinger equation as a 'second intervention', since Schrödinger had invented it solely to describe consequences of time-dependent external 'perturbations' on a quantum system. Note, however, that atomic clocks are not based on any stochastic quantum events, even though they have to be designed as open systems in order to allow their permanent reading (representing 'measurements' of the clock – see IV).
> 378

However, there is one important notion to keep in mind. Everything we can glean about the wave function necessarily includes the observer effect, the canonical ‘collapse’ into classicism. Remember that in superposition itself there is a simultaneity of all possible results which can be thought about as infinite probabilities of an outcome, a measurement, an observer effect. In quantum mechanics there are many tools derived from classical physics which work as good classical analogs of certain characteristics of the wave function. Think of this as a kind of classical, mathematical metaphor for the highly unorthodox workings of the wave function. But these ‘metaphors’ are just that, they arise from classical mathematics which give us practical solutions to certain highly unusual features of superposition. But there are differences which make them particular and unique to classicism. In many cases they can deconstruct certain behaviors in the wavefunction, but they cannot work to arrive at superposition from classicism. Here are a couple of examples of how this works,

The Fourier Transform

The Fourier transformation is classical science which takes a complex waveform and mathematically breaks it down into composite waveforms which in many cases, if taken to infinity would perfectly rebuild the original waveform. This is somewhat like a human life being made by putting body parts together as we see in Victor Frankenstein's creation. More technically, Schrödinger's general wave function $\psi(q,t)$ may be Fourier transformed with respect to all its arguments – in spite of their different interpretations. This transformation defines wave numbers k in the configuration space and frequencies ω. They may be rescaled into canonical momenta (in general different from conventional, that is, spatial momenta) and energies by means of Planck's constant. The Fourier transformation gives rise to a formal 'time operator', $T := i\partial/\partial\omega$, that allows one to define a continuous shift operation for frequencies: $U(\Delta\omega) := \exp(i\Delta\omega T)$. It does not in general transform a solution of the Schrödinger equation into another solution since this would require a continuous and unbounded energy spectrum.

More simply, the Fourier transform is a mathematics which can take a complex signal in the time domain and convert it to the frequency domain by approximating the original complex signal as a sum of simple sinusoidal wave forms. Plus, you can truncate how many smaller waveforms you calculate to get approximations of the original complex signal. The number of more simple sinusoidal waves can in some cases be theoretically calculated out to infinity to get an exact copy of the original signal, but practicality would not allow us to calculate an infinity of sinusoidal waves. Therefore, practically in many real-world time domain cases, the frequency domain sinusoidal waves will always only be an approximation of the original complex signal. The bottom line is that from the classical mathematics of the Fourier transformation we can model complex superposition wave functions mathematically from

component waveforms, but we cannot reverse the process and get the original wave function. Metaphorically, we can approximate life with Victor Frankenstein's body parts' creation (sinusoidal waves) but the creature cannot become alive with a bolt of lightning (cannot get back to the original wave function).

The Klein-Gordon Equation

The Klein-Gordon equation is related to Schrödinger's quantum wave function. The Klein-Gordon equation is related to the Schrödinger equation and has a general relativity counterpart. More technically, it is second order in space and time and manifestly Lorentz-covariant. The equation is used to describe all leptons which are spinless elementary particles with positive, negative, and zero charge. These elementary particles are called leptons which include electrons, electron neutrinos, muons, muon neutrinos, tau, and tau neutrinos. The Klein-Gordon equation relates to a specific part of Einstein's relativity. Generally, relativity has nothing to do with quantum mechanics, but the Klein-Gordon equation quantizes a particular spacetime aspect related to energy and momentum of relativity to describe particles which have no spin. Specifically, and somewhat technically, the Klein-Gordon equation can be used to describe the behavior of a massive scalar field in curved spacetime.

A scalar, unlike a vector which has magnitude and direction, is a quantity that is fully described simply by magnitude, such as mass, temperature, or time. A scalar field is a field that assigns a scalar value to each point in space-time. In curved spacetime, the scalar field is defined as a function of the coordinates of the spacetime points. The scalar field can be used to describe various physical phenomena, such as the Higgs field in particle physics and the inflation field in cosmology. In general relativity, the scalar field can be used to describe the gravitational field. The scalar field can be coupled to the curvature of spacetime, which allows the scalar field to interact with gravity. The scalar field can also be used to

describe the dark energy that is responsible for the accelerating expansion of the universe. [379]

The mass term in the Klein-Gordon equation can be derived using the conservation of the energy-momentum tensor. The equation can be solved for a massless complex scalar field in Reissner-Nordström spacetime. [380] Therefore, the Klein-Gordon equation is compatible with a certain aspect of a relativistic wave equation that is second order in space and time and manifestly Lorentz-covariant. An equation is said to be Lorentz covariant if it can be written in terms of Lorentz covariant quantities.

What does this mean? Simply put, Lorentz transformations are underlying spacetime manifolds. A manifold is a mathematical concept of a topological space in which every point has a neighborhood that is homeomorphic to the interior of a sphere in Euclidean space of the same number of dimensions. Ok, maybe that was not so simple, maybe more simply, think of it as a mathematically smooth continuous surface which is described by Euclidean mathematics. Euclidean mathematics has vector fields of multidimensional points which describe the surface of a smooth structure and allows smooth differential equations to map from one surface to another surface and back again. General relativity spacetime is similar in how four dimensions of spacetime can go smoothly forward and backward in spacetime from one point to another. General relativity's spacetime can be thought of as a smooth and continuous geometric surface which is a manifold. Manifolds are made up of multiple dimensions which, at each point in spacetime, have certain characteristics described by functions or operators (specifically, scalars, four-vectors, four tensors, and spinors).

The key property of such equations is that if they hold in one inertial frame, then they hold in any inertial frame; this follows from the result that if all the components of, say, a tensor vanish in one frame, they will also vanish in every frame. This condition is a requirement according to the principle of general relativity, i.e., all

relativistic laws must make the same predictions for identical experiments taking place at the same spacetime event in two different inertial frames of reference. The idea of invariant transformations is that you can define any accelerated region of space in the mathematics of general relativity and going from that accelerated region to another accelerated region of spacetime will not change anything. Klein-Gordon is also related to Fourier time-frequency solutions, Fourier transformations, of the wave equation. Metaphorically, the Klein-Gordon equation is sort of like thinking in Mary Shelley's Frankenstein tale that dead heart muscle tissue (massive scalar field in general relativity's curved spacetime) can be galvanized going from dead heart muscle tissue to a beating heart (the spooky quantum wave function for leptons – like impossibly going from classicism's branch from the observer effect back into the quantum wave function).

What I am trying to show here is that we can find mathematical analogies of metaphors drawn from classicism, the observer effect, which gives us aid in understanding very specific parts of the wave equation. But there are very distinct differences like the simultaneity of the wave equation. The 'time problem' of the wave function's superposition is best described as how do we think about "Everything Everywhere All at Once."

Chaos and Unitarity

In non-relativistic quantum mechanics, time is regarded as universal and absolute. By using the terms 'universal' and 'absolute' quantum physics does not mean it gives some sort of 'physical' or historic meaning to time. It is much more restricted and simpler than that. The use of 'time' in quantum physics means it is simply used as a classical background parameter which is external to the system itself, merely a utilitarian tool for research and experimentation. It is more like snapshots where we have one state here and another there and what, if any, is the relation between the states. The

notion of ‘time’ in this case is purely utilitarian. Certainly, one could argue that the implicit assumption of classical time is still implicit (e.g., as a succession of ‘now’ moments) but explicitly that is not what is meant. In quantum mechanics the use of the terms ‘universal’ and ‘absolute’ is synchronic. By ‘synchronic’ we mean purely relational which does not try to investigate what time ‘actually is’ – its history or meaning. Synchronic time is a-historic. In thinking of time in quantum physics as ‘universal’ and ‘absolute’ there is no philosophical import meant or implied to time itself as if it were a phenomenon or was derived or arose from phenomena, from physics.

Quantum Field Theory

Worldlines, worldsheets, and worldvolumes are concepts that are used in quantum field theory. In quantum field theory, a worldline is the path traced out by a single particle in spacetime. A worldsheet is a two-dimensional surface traced out by a string in spacetime. Finally, a worldvolume is a higher-dimensional surface traced out by a brane in spacetime. These concepts are used to describe the behavior of particles, strings, and branes in spacetime. [381]

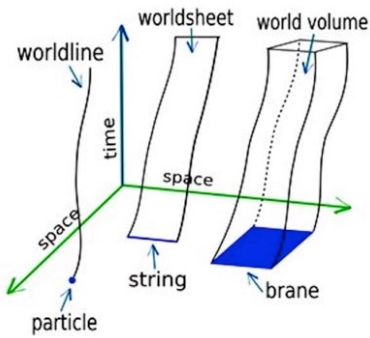
Worldlines, worldsheets, and worldvolumes are concepts in physics that help us understand the spacetime of an object or a system. They are used to describe the path of an object in spacetime, the surface traced out by a string in spacetime, and the volume traced out by a membrane in spacetime, respectively. In special relativity, the concept of spacetime is used to describe the four-dimensional universe, where time is considered as the fourth dimension. The worldline of an object is the path it takes through spacetime, and it can be used to describe the motion of the object. However, the concept of worldlines does not provide a direct account of time. Instead, the concept of proper time is used to describe the time experienced by an object moving through

spacetime. Proper time is the time measured by a clock that is at rest relative to the object, and it is related to the spacetime interval between two events along the object's worldline. Therefore, while worldlines, worldsheets, and worldvolumes are important concepts in physics, they do not provide a direct account of time. Instead, proper time is used to describe the time experienced by an object moving through spacetime. [382]

There is a theoretical area of quantum physics which gives an account of time from quanta. This will be discussed in more detail later but for now it does so by deriving 'worldlines' and 'worldsheets' from networked quanta. Worldlines, worldsheets, worldvolumes are geometric maps like contour lines of an elevation topological map. Instead of elevation gain these maps can show physics events in any number of dimensions. For example, they can map out the geometric curvature of spacetime in relativity which would effectively show gravitational differences for different regions of spacetime in four dimensions. This could equally show the effects of relative frames of time contoured with how time changes in certain regions relative to the speed of light as in special relativity. As we will see there is a basic time constant of the universe which has been an enigma since it was discovered in 1900. The Planck constant is equal to 5.39 $x10^{-44}$ seconds. This is the amount of time for light to travel one Planck length of 1.616255(18) x 10^{-35} meters. This is the smallest unit where gravity becomes effective. [383] However, this constant, like all the universal constants, has been bumped into in the middle of the night so to speak but no one really understands why they appear to be universal.

Later, I will elaborate on some theories in quantum physics which do try to explain the phenomenon of time that we might think of as diachronic. By diachronic I mean how temporality, history, might arrive purely from physical phenomenon as 'worldlines, 'worldsheets, or worldvolumes'. Worldlines, worldsheets, worldvolumes are geometric maps like contour lines of

an elevation topological map. Instead of elevation gain these maps can show physics' events in any number of dimensions. For example, they can even map out quantum events of particles, strings, and branes as the diagram below shows,



In this case, by the word 'history', I am not talking about classicism's historic narrative. As I will discuss later in the section entitled "Loop Quantum Gravity" 'history' can be thought of as a kind of stored memory in phenomena. Certainly, the notions of 'worldlines', 'worldsheets', and 'worldvolumes' might and has been extended philosophically but in physics theory itself, it is purely a phenomenon arising from the quanta, from zero-point energy or vacuum energy.

Quantum mechanics is stochastic or statistical, discontinuous, quantum 'jumps' between stationary states. In the time dependent Schrödinger wave equation time dependence is only understood in superposition as a relationship between quantum wave interference states. This is called perturbation theory or how things react when they are perturbed. In contrast, 'observables' which means collapse or branching into classical physics is not a continuum of time from superposition to classicism but a spooky rupture meaning kinematic, simply mechanical operators (functions), vectors, points

without any association to classical forces, motions, or continuums which might be inclined to link the gap from superposition to classicism. There is no link except in the observation and that already implies classicism, the world of commonsense. But working quantum physics thinks of spacetime as stochastic, totally separate statistical, now moments with no on-going relation or history fill the gap that unifies and makes continuous like our common notion of time. 385

What we think of as historical time, diachronous time, the flow of time is like some kind of glue between, causal relation between, two states. Synchronous time is like cutting the film of the story of history up into a million pieces, throwing them up in the air and trying to piece together a story from millions of unassembled parts (or perhaps more like the state reduction into classicism of the wave function). The problem is that quantum physics has indisputably proven that there never was **a** 'story of history'. According to the Schrödinger's wave equation, Heisenberg's uncertainty principle, and Bell's theorem about locality the story of history started as pieces of the very strange many-worlds observer effect and the spooky chaos of non-locality/non-temporality, the excess from spacetime, in which in some unclear fashion individually and collectively pieced together a myriad versions of cause and effect', 'reality', 'existence', 'truth', absolutes, etc. along with all the binary dualisms of origin which authenticated them in commonsense. If you saw the recent movie "Everything Everywhere All at Once" that is a great example of the idea in quantum mechanics of interwoven and overlapping 'many-worlds' which find no 'coherent whole' or absolute Concept.

As I have discussed unitarity is an important assumption of the quantum wave function. In this section I want to discuss some of my speculations and questions about unitarity. I only offer this as my own philosophical deliberations and not as some kind of serious physics theory. I hope it has become clear that physics and philosophy can no longer be separated as hundreds of years of our

history have been. The ancient intuitive notions of *phusis* in the West and even perhaps more ancient intuitions of rhizo-phusis as growth-*homo* (Homo sapiens) in the Proto-Indo-European theory of languages culminating in the chaogenesis of Upanishads' Brahman brings us to an abyss where growth is no longer continuous and evolutionary in a smooth sense but brings us to a gap in which emergence and novelty offer no retreat to a past. In the West history has hollowed itself out in retreat, reactionaryism, autocracy, and force as we stand on the brink of extinction. The certainties of classicism face an extremely odd and spooky abyss which quantum physics has brought to the fore. It is my firm belief that retreating is not an option. We must look forward to this chaos and listen. This section reflects some very tentative ideas of mine which may have some relevance in terms of physics.

In this section on "The Quantum Wave Function" I have discussed the importance of unitarity to the quantum wave function. I have also discussed some of the seemingly impossible, practically at least, assumptions of reversibility in the unitarity operator. We have seen throughout the history of physics the historical momentum which opposed breakthroughs in quantum physics. In my most humble opinion, in working physics this momentum is still alive and well, especially in the case of unitarity. I have discussed the observer effect as it pertains to the branching or collapse into classical particles where spacetime becomes relevant and from the perspective of classicism, reversibility is impossible. Only for the 'universal' wave function can reversibility be assumed. And certainly, there is evidence to believe that unitarity is not just a fluke or whim of reactionary physics. With all this in mind, what if there is a type of observer effect of sorts in the quantum wave function itself apart from state reduction into classicism? However, in this case, 'observer effect' is too strong. I would think of this misnomer 'observer effect' more like a kind of pseudo philosophical projection from classicism back into the wave function.

All the attempts to find a convenient solution, a historically compatible solution, to the universal wave function including John Wheeler's "*forecast of correlations that makes' physical sense*" only, are reductive. They gloss over some huge gaping voids, yawning gaps, which cannot find rest from enigma. Most physicists nowadays believe that the Copenhagen interpretation of the wave function which throws away all other branches of the non-observed branches cannot make sense – sense in the sense of nonsense for commonsense.

To try to think of the universal wave function which continues on, already inclusive a-temporally and deterministically of what we think as the 'observer effect', as branching into classicism is to try to think, in Aristotle's terms, the possibility "to be and not to be" as ***both really are true*** in the classical breakdown of the wave function. This disproves the principle of noncontradiction in Aristotle and, more importantly, the basis for the history of Western logic. Yet, our inclination is to listen to what commonsense tells us. Commonsense strives to eventually fulfill our desires by 'reconciling' the universal wave function and the observer effect into a narrative of history and thereby salvage logic. In this vacuum retrocausality is another odd but interesting attempt to bring closure and some form of logic back to our current dilemma.

I have discussed the branching or many-worlds aspect of the quantum wave function illustrated brilliantly by Schrödinger's cat in the box thought experiment. I have also discussed some research into retrocausality which seems to indicate a kind of negotiating process likely at the speed of light. This is difficult to make sense of since from the perspective of the speed of light there is no spacetime so I guess it would have to be purely epistemic? How can any kind of causality occur at the speed of light? So, if retrocausality has any merit it seems to me that it might reflect some kind of observer-like possibility in the quantum wave function. Is it possible that some kind of retrocausality observer-like possibility is inherent in the wave function itself?

We certainly cannot deny a kind of symmetry in the 'determinism' of the wave function. We can add together simultaneous and innumerous outcomes of wave-like functions and predict probable outcomes upon branching into classicism. However, there is a limit to what can practically be accomplished in experimental situations. We know that if there is only one 'universal wave function' as many believe likely, there is a gap between our experimental data and the Laplace demon 'observational perspective' of the quantum wave function. This gap represents an assumption which can never be proven perhaps in the same way as ever being able to observe a Planck sized particle (including the graviton which will be discussed more later). This gap might at least have some relevance to informational 'complexity'.

Complexity is not simply some sort of metaphysical, classical idea of something corresponding to infinite-informational-complexity. In theoretical quantum gravity physics, complexity has a limit. If nothing else, as we will see from the geometric notion of volume, there is a limit given by volume (actually the surface area of the volume) to informational complexity and entropy, there are only so many degrees of freedom, so many combinations of possibilities at a given time and volume. So, what happens when complexity reaches a limit determined by classical spacetime in any moment of universal expansion? Isometry indicates that additional degrees of freedom which do not violate our 'classical' degrees of freedom may be at work.

Visually imagine that everything, including ourselves, doubled instantly. We would never know it. As we will see, gravitational waves actually increase and decrease 'size' incessantly like tidal currents in the ocean all the time as if we were living in waves of expanding and compressing oceanic tidal waves without ever being aware of it. Isometry does this type of thing with complexity and degrees of freedom in the expansion of the universe. However, it does this with the exception that the sum total of 'tidal waves' in the universe do not cancel each other out to make a constant 'land

mass'—but even then, in that analogy there is no such thing as a constant land mass, there is erosion and plate tectonics of 'land mass' borders all throughout geological time. This is where the analogy breaks down since the overall sum of the universe is decidedly expanding and quite quickly. By the way, the expansion of the universe is not limited by the speed of light since there is no prior universe with that kind of 'laws of physics' to expand into. The net effect of universal expansion is additional degrees of freedom. In this case 'expansion' might also have some impossibly imperceptible implications for our notion of classical spacetime as expansion may well be rolled up Planck sized dimensions (as we will see in an upcoming discussion on string theory). These new degrees of freedom would still allow a limited kind of reversibility. It seems to me that in isometry limiting reversibility may mean that reversing the wave function would mean some of the novelty derived from emergence would simply vanish, not go backwards infinitely or infinitesimally.

This limit may be the practical limit we see with unitary reversibility. For example, novel new particles or properties of particles which did not exist prior to cosmic inflation would simply vanish. This may pose some problems for the second law of thermodynamics, but it may also hold some promise for why entropy has a one-way direction of time (more entropy over time). We no longer would have any relation to the static universe of early Einstein and previous classicism. But more degrees of freedom in complexity might be indicated by emergence and novelty. I want to take a small step back before going on the emergence to reflect on symmetry.

Symmetry is a major plus when it comes to working physics. At the very least it plays well with general relativity. So, there is some sense of symmetry which is legitimate and 'real'. This is obviously a major concern of unitarity and reversibility. Previously, I briefly mentioned the notion of broken symmetry in the section entitled, "Schrödinger's Cat". Broken symmetry is what happens when the

wave function collapses or branches. The symmetry of wave function's determinism, the ability to make useful predictions about probabilities from a change of wave function superposition interactions, is 'broken' by the 'fall' into classicism, collapse, or branching. This 'fall' is only apparent to us from the observer effect. The wave function itself is not 'phased' but continues on in the La Place demon style to have a relationship to any and all determinations of informational complexity. If informational complexity actually 'grows' (*rhizo-phusis*) as isometry appears to suggest, emergence and novelty would certainly qualify as a result of complexity which has added new degrees of freedom.

Normally, in the unitary assumption of Schrödinger's quantum wave function, any time dependent state transitions would, in theory, have to work the same forwards and backwards in mathematical Hilbert space. Hilbert space maps all combinations of amplitudes between two locations. This means a transition from a point at say 'x' which maps to a point say 'y' would also have to map from 'y' to 'x'. Hilbert space does not change. It does not expand or contract. But we know that, for the universe, space has expanded from the Big Bang. Isometry may solve the problem of the universe's expansion by geometrically allowing the space to expand without affecting the distance between two points.

Think of all the points on a circle. If you place the same circle in a sphere, the circle will still have all the same distances it had before, but it will also have a completely new and novel set of points it never had before. So, while degrees of freedom in the universe which only contained the circle are all the same, new degrees of freedom are available in the degrees of freedom a sphere has. or ...in the degrees of freedom a sphere has. What works nicely is what happens if the universe were to contract.

According to general relativity all 'laws of physics' must work the same no matter what relative frame is under consideration. Another way of saying this is that a prediction we make in one inertial frame must apply to all inertial frames. There is no

exception to this universal 'logic'. The fancy word for this is Lorentz-covariance. There are no inertial frames which are invariant (exceptions) in general relativity. Here is a more technical explanation,

- Lorentz covariance is a property of the underlying spacetime manifold, or it underlies all spacetime. It has two distinct, but closely related meanings:
  - A physical quantity is said to be Lorentz covariant if it transforms under a given representation of the Lorentz group. According to the representation theory of the Lorentz group, these quantities are built out of scalars, four-vectors, four-tensors, and spinors. In particular, a Lorentz covariant scalar (e.g., the space-time interval) remains the same under Lorentz transformations and is said to be a Lorentz invariant (i.e., they transform under the trivial representation). An equation is said to be Lorentz covariant if it can be written in terms of Lorentz covariant quantities.
  - The key property of such equations is that if they hold in one inertial frame, then they hold in any inertial frame; this follows from the result that if all the components of a tensor vanish in one frame, they vanish in every frame. This condition is a requirement according to the principle of relativity, i.e., all non-gravitational laws must make the same predictions for identical experiments taking place at the same spacetime event in two different inertial frames of reference. [386]

Lorentz transformations are used in Einstein's field equations. The Lorentz transformation is a six-parameter family of linear transformations from a coordinate frame in spacetime to another

frame that moves at a constant velocity relative to the former. [387] Einstein derived the Lorentz transformation equations from his two fundamental postulates, and that such transformations in turn mathematically confirmed the validity of his two fundamental postulates, all of his coordinate measurements, and his twin concepts of the Relativity of Distance and the Relativity of Simultaneity. [388] The Lorentz transformation was later used by Einstein to demonstrate the incorrect assumption of the Galilean transformation in Classical Physics, and as a result, Einstein's special relativity theory includes the Lorentz transformation. [389] The field equations of general relativity are based on the principle of general covariance, which states that the laws of physics should be the same in all coordinate systems. [390] The Lorentz transformation is a key component of the principle of general covariance, and it is used to transform the coordinates of a physical system from one reference frame to another. [391] The Lorentz transformation is an essential part of Einstein's field equations.

The bottom line is that there is a universal logic to spacetime. Any physical phenomenon which can be described in general relativity will apply no matter where you are in the universe. The universe is continuous and smooth. The universe accomplishes this by the mathematics of infinites. Infinities work forward and backward in spacetime through transformations. The mathematics of transformations maps certain existing conditions anywhere in spacetime without having to change its logic. The universe is beautifully symmetric and does not break from that symmetry anywhere. Ah, you might think, what about black holes? There is a mathematical answer to singularities – they resolve to infinites. But then sadly, infinities for physicists are like magic wands in the hands of sorcerers. Physicists abhor infinites but mathematics insists on them at times. The question which comes to the fore is, physically – what do we mean by infinite? This seems to be an unbridgeable gap but necessary requirement of classicism and even now what we call classical relativity. Quantum physics has its own

mathematics which transforms or maps regions of quantum mechanics to other regions. It is called Hilbert space. But don't let the word 'space' here fool you. It is not your mother's 'space'. It is the 'space' of spooky entanglement.

Hilbert space is a mathematical concept that is used to describe the state of a quantum system. It is a complex vector space with an inner product that satisfies certain properties. Lorentz covariance, on the other hand, is a property of the underlying spacetime manifold. There are some research programs that aim to incorporate Lorentz covariance into Hilbert space. One such program is the "Space from Hilbert space" program, which proposes that spacetime is not fundamental, but instead emerges from the entanglement structure of an underlying Hilbert space. However, this approach faces the challenge of generating Lorentz-covariant dynamics from a randomly chosen Hamiltonian. [392] In other words, true to the wave function this attempt bumps into chaos. Another approach is the Lorentz-covariant formulation of loop quantum gravity, which maps the conventional quantum spin network of Hilbert space to a space of functions where Lorentz covariance is manifest. [393] Loop quantum gravity will be discussed later. In this approach, quantum states are realized by a generalization of spin network states based on Lorentz. [394] Spin networks were described by Roger Penrose (1931-) in 1971. Spin networks are a type of diagram which is made up of nodes and lines which attach to the nodes. These nodes and lines connect quantum wavicles and fields. These networks are used in loop quantum gravity (to be discussed later) to correlate a 'quantum state' to a 'gravitational state'. This allows loop quantum gravity to 'play' in Hilbert space. In so doing it makes possible a bridge between the micro of the quantum world to the macro of the relativity world. The bottom line is that just as relativity maps out spacetime as relative dimensions in the 'block universe' in which transforming, conversing between regions of spacetime, can be done continuously forward and backward in time, so loop quantum gravity tries to find a quantum wavicle path which

gives rise to gravity. We know that in the Planck era of cosmology this ostensibly happened so there must be a way to accomplish this feat in physics. We also know that gravity was a product of the Planck era which may have arisen from the theoretical particle we call the graviton (to be discussed later). And this brings me back to one of the most fundamental assumptions in Schrödinger's wave function – unitarity…going forward and backward in the wave function. Note, we 'think' of this as go forward and backward in 'time' but by 'time' we are really meaning going forward and backward in mathematical superposition of the wave function. The very odd duck of superposition happens exterior to spacetime, our classical world. It is really more like "Everything Everywhere All at Once."

In unitarity all the transitions must map forward and backward in Hilbert space. Suppose in new degrees of freedom given by the expanding universe a novel new particle or property of a particle which occupied our sphere universe appeared between the Milky Way and Andromeda. In the current notion of unitarity and Hilbert space there is nothing new under the sun so to speak. Going backwards would mean the photon would never cease to exist. It would just keep getting infinitely smaller. So, it could not account for something extremely new and novel in the universe. In a way, the current Hilbert mathematics is static. Its map does not change dynamically. However, we know that from 10^{-43} after the singularity of the Big Bang informational complexity, degrees of freedom, and limits of entropy have changed.

Isometry wants to accommodate novelty and emergence without disrupting the apparent universe of Hilbert space, unitarity, and Schrödinger's quantum wave function. You could think of it as a kind of transformation which allows for emergence and novelty, something unexpectedly new. But the word 'transformation' is somewhat stretched here because it implies a different, unique mix of the same matter not necessarily unforeseen new matter. A practical way of thinking about this has to do with signal encoding.

Let's say that we have a message we want to send but we are going to send it in a very noisy medium which would alter the message. If we could encode all the characters of the message redundantly with a code, we could decode them on the other side. Isometry can be thought of as a way of encoding all the original message (less degrees of freedom) in a more complex message (more degrees of freedom) which, when decoded, would make the original message look all the same. Here is another way to think about the reason isometry makes sense.

The Big Bang singularity is a likely theory but an anomaly of cosmology. Using general relativity, the singularity had infinite density and temperature at a finite time in the past we think of as time zero. However, time zero did not exist as neither time nor space existed. The phenomenon that started the universe is known as 'gravitational singularity' and is not considered an adequate physical explanation until 10^{-43} seconds. From zero (whatever that means) to 10^{-43} seconds is known as the Planck era. Not much is known about this era, but it is believed that all four forces we see today, gravity, electromagnetic, the strong and weak nuclear forces, were one unified force. I will get into the details of cosmology later but for now, there were no atoms, no photons, no spacetime as we recognize now. The universe at 10^{-43} seconds old was 10^{-33} centimeters and opaque. At 10^{-43} seconds it is believed that gravity broke out from the single unified force leaving the other three forces still combined into one force. As I will discuss later, 10^{-43} seconds would have been when the 'graviton', the quanta of gravity, came into existence. From the embryonic expansion of the universe, the universe became increasingly complex. For example, atoms would not have existed in the Planck era. In the earliest moments of the Big Bang energy was distributed uniformly. Therefore, the expansion of the universe also started with very low entropy. In quantum gravity theory and string theory there is a limit to how much information can be stored in a given volume of space. The reason for this is not due to the volume itself but to the surface area

of the volume. [395] Since the universe was extremely small at 10^{-33} centimeters the amount of information or degrees of freedom would have started out small and grow as the universe aged. As the universe's total volume expanded, complexity increased. The information limit would begin to increase offering more complexity. This also means entropy would start to increase. All this was due to the fact that degrees of freedom were increasing.

However, do not try to associate the actual singularity with what happened at 10^{-43} seconds. From time zero to 10^{-43} seconds, we have no clue what was going on. However, do not try to apply the classicism of cause and effect to try to surmise what the singularity was like. The best way to think of this might be that the singularity was the universal wave function. It was not real or ontological. Neither was it epistemic nor ordered by any of our classical notions of truth and what constitutes truth. The look backwards from 10^{-43} seconds is like trying to look backwards from collapse or branching into classicism to the very strange quantum wave function. The singularity we are referring to was pre-spacetime, pre-cause and effect…not anything like 'our' spacetime. It would have infinite possibilities, unimaginably highly complex, exceeding our feeble categories of order and disorder. All information would have no classical 'materiality' nor would it be purely 'ideal'. We drag all that historic baggage with us in futility. I prefer the notion of chaos. There were no either/or-s, no binary dualisms, neither was it all the 'same'. Could we call it pure possibility or actuality as Aristotle might have? As an intuition, yes. But what we have learned is that there is an unaccounted-for excess which has brought us to an abyss in which history is confounded, commonsense can only gape at the chasm. Nothing can bridge or ease our bewilderment. We must find a place which allows our astoundment to sensually grip us in our embodiment…and listen for the voice of the radically other.

With all that said, when we use the wave function in practical situations, we find that there is a kind of determinism. We know in

very controlled situations where environmental interferences are minimized, probabilities of the wave function are conserved. We can link multiple pure or mixed states in superposition and determine a probability of how the classical collapse or branch will turn out upon observation. The history of quantum physics from the 20th century onwards has speculated that this trend might continue as increased complexities of the environment are allowed to leak into the experiment. However, quantum physics is just scratching the surface of how complexities arise with regard to the quantum wave function. I will discuss more of what is happening in terms of complexity, information, emergence, and novelty later. Prior to that discussion, I will just throw out some speculative ideas which I have no basis for other than imagination.

Is it possible that the quantum wave function reflects a kind of symmetry back to us as we gaze with Orpheus into the quantum wave function itself? Is it Eurydice that we see in symmetry, but the eternity of the underworld eludes us in the blankness of our stare? Might we find one day that when complexity and degrees of freedom reach a certain limit, we may also discover a limit to our 'determinism' of the wave function? Is determinism in the wave function really universal? Is it absolute? How would absolute determinism account for emergence and novelty? Certainly, it could account for transformation, rearrangements of particles in a static universe. But could it account for emergent new degrees of freedom, increasing complexity from 10^{-43} seconds after the Big Bang, and entropy which is not reversible into infinitesimals, by rewinding time backwards into infinitesimals? Or is this yet once again dragging classicism along with us as the corpse of Eurydice? If the quantum wave function reflects a limited symmetry back to us vis-à-vis unitarity and reversibility this could possibly even go so far as to account for historic certainties of binary dualisms and symmetric physics intuited in classicism, spacetime, cause and effect, etc. - but only in a limited fashion. In our small steps towards reversibility, we have seen that the square of the wave function has

a deterministic predictability, fundamentally probabilistic but stochastic, statistically. Within certain experimental severe environmental constraints relative to a universal determinism, can we really make the leap to what is likely more of a metaphysical idea than a provable idea of the 'deterministic universal wave function'. We have taken certain structural baby steps to make us believe that further structural steps will lead us to further structuralism reinforcing the 'universal wave function idea' which, in that case, would be absolutely deterministic every step along the way. But what if that assumption is not true?

We know that complexity has a limit (perhaps as geometric volume). Beyond that, there is chaos from a classical point of view, but emergence and novelty which may not adversely affect classicism as a limiting case and even a limited observer effect of the quantum wave function itself which further may even imply a certain unclear and impractical amount of reversibility. However, it seems plausible to me that informational complexity may reach a limit which we cannot describe as even 'transformational' but rather as chaos in which history has no account. At this juncture we must give up the classical idea of perpetually 'being able to be able', adding structure upon structure until we arrive at La Place's demon, or perpetually transforming binary oppositions into higher binary transformations, e.g., Hegel's Concept which must forget itself in order to be 'absolute' thus giving way to space and then time yet once again for the first time. [396] As Homo sapiens we are mortal, inescapably classical, fallen from the oddity of the wave function. From the chasm of 20th century physics which emerged in the observer effect of the wave function we have gleaned a mirror which looks back at us in the apparent determinism of the wave function, but informational complexity required by the wave function to finally validate it as the 'universal wave function' of La Place's demon is of the order of Planck's constant which practicality will never allow us to directly observe. Is this lack due to the inadequacy of our current structures/knowledge to gleam incredibly

bizarre phenomenon or is it the limitation of classicism, mortality, our inability to be able to peer beyond the veil limiting informational complexity? The circularity of the East and the progressive linearity of the West both find their final limits in emergence and novelty, chaos which is not simply disorder but a peculiar abyss which looks back at us, face to face. The face to face of the other cannot remain passive. It imposes necessity upon us, before choice. Responsibility is before the freedom of choice which each time singularly imposes responsibility before we can even choose a response. The imposition of responsibility is Ethics. I will explore all this later in the major section entitled, "Phusis: Towards Radical Exteriority as Philosophy". The 'fall' into classicism and the tree of life have many interesting associations in creation myths which I will discuss later but for now,

…as the sun nurtures the tree of life, rhizome nurtures growth (*rhizo-phusis*).

Entangled mesh, you dirt-dark roots
'going under'; unseen, cool earth
Rising up, you praise-filled ascension
Boughs outstretched; mirrored mesh
Sun soaked self
Sunk deep from night
We trees are thoughts
We leaves our passions
We forests; worlding
Budding moments
Whirling wind
On spinning orbs
Exploding out
We fertile voids [397]
Rhizome –
winds breezing,
waves dancing,
entangling,

branching,
emerging novelties,
cascading towards many-worlds.
Below,
Endless roots,
Lost complexities,
Radical alterities,
Before the gods, chaos
I face the other. 398

What About Objectivity?

For now, I just wanted to address what I can hear now as I write this, “What, you believe there are no objective realities? You think we just make up everything in ‘reality’? Go jump off the Grand Canyon and see where that gets you?”

To be clear, this book is not about the marketing slogan, ‘perception is reality’. ‘Perception is reality’ is about manipulating perception to achieve a goal. This can happen with products, politics, religion, or anything which advances a vested interest. This book is aimed at decisions we make and the presumed basis for these decisions. As I have pointed out, the lapse into pure subjectivity, saying if nothing is real just go jump off the Grand Canyon is an easily accessible narrative which conveniently misses the point. This point would be a fabrication of yet another vested interest. This book is not suggesting that there is no classicism. This book is not suggesting that histories and collectivities are ‘mere’ illusions. We are classical. Even ‘are’ ‘is’ classical. The quantum wave function in its branching certainly produces, gives rise to classic science. Gravity works here. If you jump off the Grand Canyon, it will not end well.

What is at work in quantum physics and the spooky observer effect is not about ‘objective reality’. It is about the choices we make in our branching and how they play together with the results

we find. It is about the co-determining in choice and observation. The wave function collapses together with us as our history *and* as classical physics. This is what I term *phusis*. The quantum wave function defies pigeon holing, easy ready-made answers. It places responsibility clearly on our shoulders. There is 'no exit' from responsibility. We 'are' what we become, sounds trite but has profound ramifications. If you want to believe you are superman and can fly off the Grand Canyon, you are codetermining fate and choice. You will live with your choice for a few seconds anyway before fate kicks in. The point is that you choose from a plethora of possible histories which congeal into an actual history. Whatever, histories, absolutes, mass marketed agendas, political ideologies, certainties, you name, if you choose it, it will also choose you. This is spooky. This is reciprocity. Some call these consequences. Some call this karma. Whatever you want to call it, you do it every day with every passive or active choice you make.

What I hope to show in this book is about dominant classical histories which inform us about truth, about values, about the reasons why we are on the verge of climate disaster and nuclear holocaust. The choices we as humanity have made are catching up to us. We are staring into the abyss of extinction 'fiddling while Rome burns', all in service to the dominant themes of history which brought us to this grandest of canyons.

In my discussion of "Genesis: The New Creation Myth" I am not referring to an 'all or nothing situation'. I am not saying that there have not been and never will be women who are tyrants. I am referring to dominant themes in our history. I find it hard to believe that anyone could think that there has never been a dominant history which subjugated women to dominant masculine histories. It seems clearly reasonable that men have deemed themselves the authors of origin, the protectors of truth, the progenitors of violence and wars. In general, women have not started wars. In general, they feel for their sons and daughters, which causes them to hesitate, to withdraw from the violent decisions of his-story. They know in

advance they will live the silent grief of the loss of their loved one. They suffer the pain of childbirth long after the birth of their child. We, as men, need to heed them. We need to learn from them their wisdom. Guys, ask almost any woman you know, “Do I need to listen to you more”? The general consensus might shock us guys (or not). I find dominant narratives of history have led us to this precipice. We face the other before choice. Responsibility is before choice. Ethics is recognizing responsibility. We can hold fast to our dominant ‘realities’ or we can let exteriority give us pause, give us wisdom, give us restraint from the narratives we tell ourselves. I will get into all this much more in the second half of this book.

Listen, quantum mechanics is not philosopher’s weaving their academic tales in the hope that someone cares. Most folks’ commonsense tells them the if nothing else, science is ‘real’. Whether philosophers like it or not we must start from commonsense not academic nuances. That is why I have decided to not just write a book on philosophy but on physics. I want to appeal and contest some of the commonsense ideas we attribute to science with science. The science of quantum physics which, by most scientists' account, has delved much deeper into physics (what I deem *phusis*) than any other science in our history. The questions and the ramifications of quantum physics, if nothing else, bring us to an abyss. We face an alterity not accounted for by our classical history. The only thing which remains for commonsense is, “What will you do with this?”

The Mysterious Quantum Wave function and Other Histories

Contemporary quantum physicists have written extensively about the philosophical implications of quantum physics. The influence of quantum physics on philosophy has been a topic of discussion for many years. There is even an entire and very active field of quantum philosophy. [399] Many of the founders of quantum physics up until the present have written extensively about the

philosophical implications of quantum physics. The list is too long to list here but here are some highly notable physicists that actively pursued the philosophical implications of quantum physics which include Niels Bohr, Erwin Schrödinger, David Bohm, John Bell, Eugene Wigner, Hermann Weyl, Paul Dirac, John Von Neumann, and Leonard Susskind. [400] The first version of Everett's PhD thesis was entitled "The Theory of the Universal Wave Function" where he stated,

> Since the universal validity of the state function description is asserted, one can regard the state functions themselves as the fundamental entities, and one can even consider the state function of the whole universe. In this sense this theory can be called the theory of the "universal wave function," since all of physics is presumed to follow from this function alone. [401]

In a "Scientific American Magazine" article[402], Vlatko Vedral, an entangled state professor at University of Oxford and at the National University of Singapore, tells us that many people are under the impression that quantum effect's weirdness only pertains at extremely small scales. Even many older physics textbooks state that quantum theory applies exclusively to very small scales like particles, atoms and molecules. Many folks think that quantum theory does not apply to biological, astronomical and classical histories of science. Common sense informs us that somewhere between the extremely small and the extremely large a boundary divides quantum physics from what we simply think of as 'reality'.

Vlatko Vedral states that nearly all quantum physicists believe that quantum physics is much more important than classical physics. Contrary to what many people think, physicists think of classical physics as a useful approximation of quantum phenomenon. In terms of many interpretations of the quantum wave function, the 'useful approximation' of classical science is a

dominant narrative. We tend to think that because we cannot easily see quantum phenomena it is not 'real' in terms of what history has ascertained as 'objects' as 'things'. The reason we tend to think this is because quantum systems do not act in a way that common sense has dictated. Vedral tells us that even early on quantum physicists did not understand how quanta operated on large scales. But those days are long gone as we will see. There is an incredible amount of data accumulating which bubbles up in many fields of quantum physics theory and experimental results. This data gives us a much clearer picture of how entangled quantum systems affect many areas of classical physics including cell biology and, as we will see, brain/mind neurology.

The implications of the notion of the universal wave function are staggering. There are many burgeoning areas of research which are investigating how the quantum wave function interacts in large, macro systems including plants, animals, and humans. There is active research going on which is unveiling how quantum entanglement is involved in biological systems. I will get into this more later but for now here are a few of these studies:

Scientists have already discovered that entanglement can occur in biological systems. A recent study has found that quantum entanglement can be created from a biological system, specifically in a bird protein called cryptochrome.

> Magnetoreception is a sense which allows an organism to detect the Earth's magnetic field. Animals with this sense include some arthropods, molluscs, and vertebrates (fish, amphibians, reptiles, birds, and mammals). The sense is mainly used for orientation and navigation, but it may help some animals to form regional maps. Experiments on migratory birds provide evidence that they make use of a cryptochrome protein in the eye, relying on the quantum radical pair mechanism to perceive magnetic fields…
>
> Research took a different direction in 2000, however,

> when Thorsten Ritz and colleagues suggested that a photoreceptor protein in the eye, cryptochrome, was a magnetoreceptor, working at a molecular scale by quantum entanglement. [403]

The current working theory is that when a photon hits bird cryptochrome, its energy can perturb molecules within a protein, catapulting a pair of molecules into an unstable entangled state so fragile that it can be affected by even the subtle energetic pulse of Earth's magnetic field. [404]

> In entanglement terms, "a fairly long time" is still only about 100 microseconds (or one ten-thousandth of a second). Even in ideal laboratory conditions, which usually involve powerful vacuums or astoundingly icy temperatures, artificial quantum entanglement can unravel in just nanoseconds. And yet, in the wet, messy environment of a bird's eye, entanglement holds. "It seems nature has found a way to make these quantum states live much longer than we'd expect, and much longer than we can do in the lab," Gauger says. "No one thought that was possible." [405]

A study released in 2022 reports that the brain may be a 'non-classical' entangled quantum system,

> The aim of this study was to show that the brain is non-classical. We assumed that unknown brain functions exist which can mediate entanglement between auxiliary quantum systems. The experimental detection of such an entanglement created by the brain would then be sufficient to prove cerebral non-classicality. We found experimental evidence that such entanglement creation occurs as part of physiological and cognitive processes. [406]

This study found that the brain may be entangled in consciousness. A signal in the brain which seems to indicate consciousness is called the HEP.

> The heartbeat-evoked potential (HEP) is a brain response to each heartbeat, which is thought to reflect cardiac signaling to central autonomic areas and suggested to be a marker of internal body awareness (eg, interoception).[407]

This signal is not present when participants in the study were asleep. This and other areas of research are finding intriguing ways in which warm and wet environments can exhibit quantum effects in a macro environment. Oh, did I mention that quantum physics is already being used in many other ways like: [408]

- Semiconductors: These materials, which have properties between conductors (like copper) and insulators (like glass), underpin everyday electronics such as computers, LED lights, TVs, cell phones, and smart devices. Our understanding of quantum mechanics directly influences the rise of all electronics.
- Lasers: These devices emit concentrated beams of light due to coherent light waves with identical frequencies and waveforms. The generation of laser light relies on stimulated emission, a quantum process.
- MRI Scanners: Magnetic Resonance Imaging (MRI) devices use quantum principles to create detailed images of soft tissues in the human body. They rely on nuclear magnetic resonance (NMR), a quantum phenomenon.
- Solar Cells: Quantum mechanics plays a role in the behavior of electrons within solar cells, allowing them to convert sunlight into electricity. [409]

Oh, did I mention toasters, fluorescent lights, and atomic clocks?

So, how could quantum chaos give rise to spacetime? I have already dealt with how quantum wave function complexities are chaotic on an environmental scale. Quantum gravity has been one leading area of research for many decades which deals with exactly how quanta give rise to spacetime. I will get into this in much more detail later but to give a prelude, blackhole research has provided us with answers on how chaos and extreme deformations of spacetime are linked.

> "This relationship indicates that spacetime itself does not exist fundamentally, but emerges from some quantum nature," says Goto. "Physicists are trying to understand the quantum property that is key."
>
> The original thought was that quantum entanglement—which links particles no matter how far they are separated—was the most important factor: the more entangled particles on the boundary are, the smoother the spacetime within the bulk.
>
> "But just considering the degree of entanglement on the boundary cannot explain all the properties of black holes, for instance, how their interiors can grow," says Goto.
>
> So Goto and iTHEMS colleagues Tomoki Nosaka and Masahiro Nozaki searched for another quantum quantity that could apply to the boundary system and could also be mapped to the bulk to describe black holes more fully. In particular, they noted that black holes have a chaotic characteristic that needs to be described.
>
> "When you throw something into a black hole, information about it gets scrambled and cannot be recovered," says Goto. "This scrambling is a manifestation of chaos."
>
> The team came across 'magic', which is a mathematical measure of how difficult a quantum state is to simulate using an ordinary classical (non-quantum) computer. Their

> calculations showed that in a chaotic system almost any state will evolve into one that is ‘maximally magical’—the most difficult to simulate.
>
> This provides the first direct link between the quantum property of magic and the chaotic nature of black holes. “This finding suggests that magic is strongly involved in the emergence of spacetime,” says Goto. [410]

Quantum physics and the wave function cannot be segmented in some historical narrative which makes it simply responsible for stuff, things, matter, etc. The greatest minds in quantum physics were perplexed with the dilemma of how quanta and the wave function upended centuries of philosophical assumptions about what ‘is’. They wrote and spoke about it openly. Even now there are highly acclaimed theoretical physicists which are not shy about lecturing and writing about quantum physics and its implications for philosophy.

Working quantum physicists are highly trained and intensely focused on their specialty. They also have a lot of peer pressure and intense scrutiny over everything they publish. Certainly, they are aware of the philosophical questions posed by their occupation. They react just like anybody else would. Some have an intense dislike for anything philosophical concerning quantum physics. I can’t say I blame them as there has been a lot of wild speculations about the philosophical and religious implications of quantum mechanics. Some physicists actively hold on to classical narratives in the history of science and actively defy any hocus-pocus as nonsense. Others are aware of the vast ramifications of their work but find it professionally beneficial to keep their speculations to themselves. And some throw all caution to the wind and speculate and publish about what they think all this really means. However, there is no question that the implications of quantum physics cannot be understated. In addition to studies already cited, quantum computing is also a heavily funded area of research which

is providing answers about more complex systems. Quantum physicists have been aware since the early twentieth century that humans cannot be excluded from the universal quantum wave function. Let me say again at the outset here that I am not comfortable with the commonly used terms 'universal quantum wave function'. I think it is ok as an analogical way of thinking about the quantum wave function. However, the term 'universal' includes ontological and epistemological assumptions of classicism which adds confusion to what is meant. This is even more evident when we add LaPlace's demon to the mix which notably tries to downplay the 'God' idea but is easily coopted as that idea of being, ontology (omnipresent), and even epistemological (omniscient) as all knowing. Both of these notions erect obstacles to what is meant by the quantum wave function. Occasionally, I will use the terms 'universal quantum wave function' or 'universal wave function' but simply to facilitate a kind of metaphorical visualization. The same can be said on the ontological (existence, Being, spacetime, etc.) aspect of the terms 'many-worlds' which can be useful as a visual metaphor but a barrier to understanding the informational underpinnings of Everett's state reduction or branching. In this section I want to indulge in my own wild speculations but also seemingly necessary implications of how the quantum wave function might include us in some sense as quanta, as quantum waves in superposition.

In the double slit experiment, an oddity of the wave function's state reduction into a classical particle from the observer effect is that for example, when we observe the particle's historic 'origin' into Being (if you will) from the wave function's perspective, the wavicle and 'I' are no longer separate 'beings'. The wave function's state reduction into history as 'our', the particle and 'me', does not 'see' a state reduction. We perceive a state reduction of classical origin. The wave function only sees the constant flux of 'environmentally' entangled systems. I hesitate to use the word 'environmental' because the environment of the wave function

cannot reside in any of our classical notions of existence. The complexities of the wave function far exceed any possibility of an absolute knowledge, a La Place's demon that has all knowledge of the wave function without ever branching into classicism. The complicated factor of La Place's demon is that it would also have to be intrinsically part of the wave equation as well. So, an objective perspective which does not recoil back into itself, its own observation, would seem more like a classical metaphysic. This is the classic Gordian knot. Untying one part of the knot would already have tied more knots. The beauty of the wave function is that in highly isolated and controlled experimental situations we can gain probable and highly useful bits of knowledge. Ok, that is a bit overwhelming so let me try my best to make it more accessible.

In the double-slit experiment I mentioned that we used a coherent source as in a single frequency for a photon which allowed us to see a simpler picture of the interference pattern. There is much more to this than meets the eye. Our coherent source passes through the two slits in superposition captured in the wave function and is detected by the screen meaning it updates the wave function's informational record. Our observation of the interference pattern of the waveform 'becomes' a classical particle for us but for the wave function itself simply another informational branch. We also saw this with the previous time elapsed particle points which accumulated over time and eventually took the shape of a wave interference pattern. The screen captured a certain ontological history, the informational record of the particle state's accumulation and reduction into our classical observation. We also saw that putting a detector on one or both of the slits created another kind of informational record of the wave function. While we can find a useful way to think about superposition as interfering waves, like water waves, quantum waves are very different from the water wave analogy. Quantum waves exhibit Heisenberg's uncertainty principle which states that it is impossible to know an object's precise position and momentum at the same time. Specifically, this

tells us that the existence, the ontology of quantum waves can only be perceived from a classical perspective as 'real'. This is not true of water waves which we simply already take as classical existence we simply call 'reality' or what 'is'. When the double slit screen captures a particle, for us it traces a classical history, an ontology of existence, an epistemology of truth and certainty. But for the wave function all of our ontologies, epistemologies, 'theres', 'befores' and 'afters', happened simultaneously without any state reduction. Let's add on to this.

Now let's think about our double-slit screen connected to a computer which digitizes information and sends it to a monitor screen we can look at. Our eye sees the screen and our brain interprets the pattern. We can think of all these transitions as different quantum wave functions all added together to give us a classical end result upon observation – the comprehension of the double slit results. For the sake of this analogy these transitional systems may or may not be entangled or partially entangled. After we observed the results, we tend to think that is where the wave function ended. Not true. These entangled systems continue on as if our observation were just other waves added to the wave function (but really simultaneously). We no longer have access to the wave function but that is not the end of the story. The wave function continues on in all its branches simultaneously as we are just part of the wave function - a branch, an 'other' classical history, which is the 'narration' of one branch of multiple branches' informational history. We think of the state reduction on our branch as temporally becoming our updated classical narrative – the way it is. But in every 'now', yet again, we have classically encountered an 'other', the branching of the wave function, for us a new history, new information, new origin, given by the sequence of the double-slit, the computer, the eye, and comprehension of the result. Classically, we understand this to be a temporal 'reality' introduced by our eyes and our brain to a 'me' where all this becomes the continuing saga of 'my' reality'. But the wave function has already 'accounted for'

this branch as well as all the branches of information that we no longer have access to. As in the cat in the box, we may tell someone our narrative. In this case, the other has branched off on their wave function which we no longer have informational access to.

We may think, "Well the history resulting in my brain is the *same* as the history introduced through the computer and is the same as the history in the setup of our double slit experiment", etc. But from a quantum physics 'wave function' perspective our branch into classicism can no longer recover the entire histories which led us to 'our' narrative. We can only echo our narrative to ourselves in the stern belief that classical history is continuous and 'real'. However, in the wave function there are histories we no longer have access to which cannot be 'recalled', which exceed us. We can no longer recover them. They may as well be in other worlds or perhaps the confluence of other worlds. Our fall into classicism is called decoherence but the wave function simply 'sees' the dance of wavicles which cannot fall into a 'me' of a certain time and history as we imagine. This will be discussed much more later. For now, let's just say that through our classical state reduction we can no longer recover all the histories, the records of information, prior to our state reduction from the wave function nor can we say that they simply popped out of existence because they never were in 'existence'. We can only say that *in our world* those other histories have been lost forever.

This thought analogy makes it sound like some kind of purely subjective experience. So how could we explain how collective histories arise? But even the idea of 'purely subjective' already brings with it entire informational histories. The very idea of a 'me' and a 'them' has already been taken captive by the binary dualities of classicism. There is more to subject/object duality than that classical notion which can only be one or the other and not both. In state reduction we are not a blank tablet, a *tabula rosa*, we branch together with an entire informational record, which makes up our conscious and unconscious, our informational histories drawn from

the wells of classicism. All of these branches come together with us in state reduction. Each one of us carries an entire history of the wave function in state reduction which already informs us of a 'me' which is an existential subject. But there is no absolute synchronization of every person's fall into narratives, their fall into classicism. So, we can tell ourselves that 'I' as a monad, am the fabricator of novel histories - Nietzsche's Übermensch. Yes, but that is a choice we choose to imagine, affirm with certainty, from our informational records' fall into classicism. Memory itself is always an ongoing narrative.

According to a Psychology Today article, every time we recall an event, our memory of it changes slightly and is reconstructed neurologically with each recall. This means that our memories are not like files in our brain, but more like stories that are edited every time we tell them. The slightly changed memory is now embedded as "real," only to be reconstructed with the next recall. One implication of this is that our memories are malleable constructs that are reconstructed with each recall. We all recognize that our memories are like Swiss cheese; what we now know is that they are more like processed cheese. What we remember changes each time we recall the event. To each re-telling, there are attached emotional details. So, when the story is altered, feelings are also reshaped. [411]

However, how we imagine ourselves is a choice. Over the course of our lifetime that choice is a path. To the degree that that path leads to absolute subjectivity, a narcissistic perspective, an echo of oneself to oneself is to the same degree that any exteriority or excess to 'me' becomes only an echo. What this ignores is the excess to that narrative, the way in which wave function histories, informational records, arrive as the classical 'me'. When histories in superposition 'originate' spontaneously into histories of classicism (branching) we choose to tie these narrative threads together into my-self. The self of history is a contrived unity of substance. However, these quantum-spun narratives can never really be synchronized into any such thing as universal truth because all the

other informational branching has been lost. We no longer have access to the other branches or 'worlds' which spawn classicism.

We are not a universal demon, and neither are we a god. And neither is Hegel's ingenious Concept anything other than an all-too-classical human history. There is no absolute Concept which rises above our classical narratives. The wave function, the observer effect, and innumerable histories are mostly lost to the fall into 'my' history. Myriads of wave function entangled systems preceding spacetime, giving rise to spacetime in the cosmological Big Bang, can only find expressions in our notion of chaos, unassembled information, infinitely exceeding us and our small classical cosmos. Chaos, exteriority, exceed order ***or*** disorder, logic and contradiction, cause and effect and all these historic determinations. Certainly, we hear this resounding in Heraclitus and many of the ancient's writings. According to quantum physics there is only one wave function which pervades and exceeds all of our universals. The wave function cannot find a home in our ontologies or epistemologies, historical categories of reality and truth. The wave function's interminable and incessant, immediately branching off into informational histories, falling into what we think as classicism, brings before us personal and collective histories as narrative in which we choose as 'me' and 'we'. But other histories we no longer have informational access to elude us. In the 'now' of classical branching we interject our history. In the spread of all our 'nows' from our living past towards a projected future, our classical branching, thought of as growing coherent histories, imagine temporally 'new' histories which get recovered as 'my lifetime'. However, the stitching together of the 'my' of a branch of the wave function in some very odd fashion has already in a spooky, simultaneous, before spacetime fashion tied another knot to the Gordian knot of existence. But traveling forwards and backwards in a unitary fashion is an implied necessity of the wave function before enormous environmental complexities disappear into the limit of chaos. Classicism can never achieve its metaphysical imaginings of

the thing-in-itself from its fall into classical being, beings, and Being. The chaos from which we hide in our fig leaves vastly exceeds our classical imagination. But in our fallings into classicism in the face of the radical alterity of the other there is responsibility or echo.

QUANTUM ENTANGLEMENT

Entangled Systems [412]

Entanglement is not some odd physics phenomenon which happens in only a few odd places. It happens everywhere, all the time, and actually *is* place, and *is* time. I am not trying to sound mystic here, but it sure comes across that way because, as we will see, entanglement is awfully spooky. Just to make sure we have the horse before the cart, spacetime very likely emerges from entanglement…and entanglement exceeds cause and uncaused. All of our commonsense notions of 'reality' have their basis in history, not in entanglement. Our historic '*is*', existence, being, arises from unaccounted-for otherness. All of these statements will have to be explored in much greater detail to have any hope of making sense. So, let's go…

What is Entanglement?

Pragmatically, the notion of 'reality' is necessary but the entire mindset of 'what is real' or 'what is existence' is likely a special case, taken up in classic science and philosophy, of a much bigger picture. In this regard, there is incredible evidence coming out starting early in the 20th century and even now in quantum physics

– it is called quantum entanglement. Simply put, "*When two particles are in entangled quantum states, someone who measures a property of one particle can immediately determine the result of an equivalent measurement on the other particle, without needing to check.*" [413] And this has nothing to do with space or time. It is as if space and time do not even exist. But it gets much weirder. A theorem called Bell's inequality proves that before being observed the property has no state at all. It is as if the particle does not exist at all until you observe it. And neither is the property merely non-existent before you observe it. The property is in a hazy state of all possible values which could be infinite. Paul Dirac (1902-1984), a very famous quantum physicist writes,

> The general principle of superposition of quantum mechanics applies to the states [that are theoretically possible without mutual interference or contradiction] ... of any one dynamical system. It requires us to assume that between these states there exist peculiar relationships such that whenever the system is definitely in one state we can consider it as being partly in each of two or more other states. The original state must be regarded as the result of a kind of superposition of the two or more new states, in a way that cannot be conceived on classical ideas. Any state may be considered as the result of a superposition of two or more other states, and indeed in an infinite number of ways. Conversely, any two or more states may be superposed to give a new state... [414]

Even more, once you observe the particle it takes on a definite state and instantly so does the other entangled particle even if it was in another universe. And, after observing a particular state the entangled particles maintain that state even when no longer being observed. Entanglement is no respecter of time or distance. Entangled particles do not see what we think of as reality at all.

Spookily their capacity to not exist *and* also non-exist until observed and then to have their properties locked in a definite existent state remains that way for various durations of time.

The duration for which entangled particles retain their state after being observed depends on the specific context and the type of measurement performed. As mentioned, when an entangled particle is observed, its quantum state immediately collapses to a specific value corresponding to the measurement outcome. This collapse is a fundamental feature of quantum mechanics and is often referred to as the "measurement problem." Once observed, entangled particles remain correlated until one of them is measured. Once a measurement is made on one of the particles (e.g., measuring its spin or polarization), the entanglement is broken, and the other particle's state is determined instantly. The collapse occurs regardless of the spatial separation between the particles. It's essential to note that this collapse does not violate the speed of light or allow for faster-than-light communication. The information about the measurement outcome cannot be *transmitted* instantaneously to the other entangled particle. There is no transmission as if it was faster than the speed of light which is impossible. It is as if they were one property of the particle all along. And in the wave function they were one particle all along! No, this is not Zen. The wave function as pre-spacetime anticipated the observation all along. From our perspective in spacetime we want to think that the observation caused the property to exist as a definite value when we observed it. But the wave function as emergent of spacetime before collapse or branching had already accounted for the observer and their observation. The observer was already combined with the observed analogously like we think of two waves combining into one wave. Even more, this is not some kind of pre-determination. Nothing was pre-determined prior to the observation but in a very spooky way the wave function simply already had the combined observer with the observed…words, our historic narratives, fail here! Additionally, our observation is not

static. The wave function incessantly interacts with everything.

Entanglement can be fragile due to interactions with the environment (a process called decoherence). Environmental factors (such as temperature, electromagnetic fields, and other particles) can disrupt the delicate quantum correlations. As a result, the entangled state may degrade over time. In controlled laboratory conditions, entanglement can persist for relatively long durations (from microseconds to seconds) if external influences are minimized. However, in practical scenarios, entanglement may last only for very brief moments due to environmental interactions. Quantum technologies, such as quantum communication and quantum computing, rely on maintaining entanglement for specific tasks. Researchers are continually working on improving methods to extend the duration of entanglement. While entanglement can be created and maintained, its longevity depends on the system, the environment, and the specific measurements applied. [415]

Quantum entanglement is not just something that happens in blackholes or rare and special cases. It happens all the time. Entanglement fundamentally defies and cannot even be thought of in terms of time and space or cause and effect. As mentioned, it looks increasingly like time and space is emergent from entanglement.

> Paquette, a theoretical physicist at the University of Washington, is not alone in thinking about this strange kind of dimensional transmutation. A growing number of physicists, working in different areas of the discipline with different approaches, are increasingly converging on a profound idea: space—and perhaps even time—is not fundamental. Instead space and time may be emergent: they could arise from the structure and behavior of more basic components of nature. At the deepest level of reality, questions like “Where?” and “When?” simply may not have answers at all. “We have a lot of hints from physics that

spacetime as we understand it isn't the fundamental thing," Paquette says.[416]

Entanglement is not caused by anything in our 'reality'. Simply and profoundly put, a case of entanglement which can be achieved in the lab starts when observing one particular property of an entangled particle experimentally determines what is seen of the other entangled particle without regard to time or space.

- This determinacy is not passive observation of some prior existing condition of the entangled particles.
- Observation is 'determinate' in the sense that no prior specific condition existed for the entangled particles.
- Prior to observation, the state of the entangled particle was simultaneously all possible states or mixtures of all possible states.
- This indeterminacy of *phusis* occurs in many ways like how looking at an electron determines whether you see it as a wave or a particle. [417]

Additionally, upon observation, two entangled particles behave as if they are one particle without any regard to time or space.

- One particle of a pair of entangled particles can be right 'next' to each other, in the way we think about 'next', or a universe apart and still behave as if they were one particle.
- Because nothing can go faster than the speed of light in spacetime, it is impossible that two entangled particles can behave like this simultaneously.
- Somehow, the act of observing one particle collapses the quantum waveform so that two separate observers see identical and instantaneous results.
- On a note of caution here, 'observing' here means

experimental measurement because no one can actually see entangled particles.

- When the entangled particle is not being observed it equally has all mixtures of possibilities for whatever particular property is being observed. [418]

For the rest of this book, when I write about entanglement having no cause, I am referring to the non-spacetime interaction between entangled particle properties. When an entangled particle is observed collapsing superposition or updating information, there is no time or transmission at all between the other entangled particle's complementary property update. In this case, entanglement means there was no cause first which precedes an effect. It is not as if there is some underlying mechanism or 'reality' which somehow transferred the cause to the effect. The observer may think they are the cause of what is seen but the entangled state itself has no cause and effect 'machinery' or some invisible process. Entangled particles do not even recognize time and space or cause and effect. It is as if they are absolutely oblivious to our 'reality' except when we observe them. Since the observed effect of the property is simultaneous regardless of distance between the entangled particles, we cannot think of it as if my observation caused the effect of what the other person sees. We could just as easily say that the other person's effect caused what I saw. In other words, cause and effect is nonsense in this case. What entanglement really pushes against is nonintuitive for us. We have no easy avenues of history to find words for entanglement. But quantum entanglement has been around long before there was any such thing as 'us'.

The oddness of entanglement really reflects back on our historic, cultural, linguistic lens through how we perceive 'reality'. Entanglement turns us reflectively back upon ourselves. Philosophical phenomenology would tell us this is because of the kind of beings we are, as historic. We do not exist classically in a

simple ‘now’ moment but are spread across time in a way which merits further reflection. Phenomenology tells us our lived experience is a narrative of history. Lived experience also has a non-linear, temporal/spatial stretch. This goes against the mechanistic view of classical science built upon cause and effect. Entangled information has nothing to do with cause and effect as it does not recognize time and space. This has been proven over long distances as well as short distances.

> Quantum entanglement is a bizarre, counterintuitive phenomenon that explains how two subatomic particles can be intimately linked to each other even if separated by billions of light-years of space. Despite their vast separation, a change induced in one will affect the other.[419]

The latest record I could find for the longest experimentally proven distance for entanglement happened in 2017 at 1,200 kilometers.[420] Another interesting thing about entanglement is that these properties that are in lock step with each other only occur when they are measured.

> Entanglement links quantum particles so that fiddling with one can instantly affect another. According to the bizarre quantum laws that govern the subatomic realm, a tiny particle can be in two opposite conditions or states at once. For example, an atom can spin in one direction or the other —up or down—or both ways at once. That two-way state lasts only until the atom's spin is measured, however, at which point it "collapses" into either the up or down state. Two atoms can then be entangled so that both spin two ways at once but their spins are completely correlated, so that, for example, they point in opposite directions. Then, if the first atom is measured and found to be spin up, the second atom will instantly collapse into the down state, even if it's light-

years away.[421]

Think about this – these quantum states as up or down spin do not have to exist 'all the time' as we would expect. Both states can exist at the same time and only show a particular state when they are measured or observed. There is no 'thing' there which remains consistent over time or even over space. This could not be more 'un-classical' or even incomprehensible.

Entangled particles are not born from anything we might call 'real'. Philosophically, we might call it self-caused. From our perspective it has effects – what we call reality, time and space, cause and effect. But it is not in any way constrained by these conventional ideas. First, particles are not simply solid, 'little things' at all. They are simultaneously both particle-like and wave-like forces which can act like a coherent body under certain circumstances. There is nothing 'solid' as in the Latin notion of substance (Latin *substantia*) about them. *Substantia* is a term from metaphysics. Second, entangled particles are what a philosopher might call a kind of identity. Here 'identity' might mean, an entangled particle's unity is not dependent on time and space. But the notion of identity in our history has a universal and absolute ring to it which entanglement never knew.

More than Two Entangled Particles

It has long been proven that there can be more than two entangled particles.

> Interesting things happen if the particles in an entangled pair travel in opposite directions and one of them then meets a third particle in such a manner that they become entangled. They then enter a new shared state. The third particle loses its identity, but its original properties have now been transferred to the solo particle from the original pair. This

> way of transferring an unknown quantum state from one particle to another is called **quantum teleportation**. This type of experiment was first conducted in 1997 by Anton Zeilinger and his colleagues. [422]

For decades theoretical physicists have found that more than two particles can be entangled. If three particles were entangled observing one particle would bring all three particles out of superposition and take on statistically coherent properties.

> Physicists have entangled more than two particles before. The record is somewhere between 14 particles and 15 trillion, depending on whom you ask. But these were only across short distances, just inches apart at the most.[423]

Physicists place a high bar to reach from possible to actual. Actual proof for any kind of entanglement must be based on non-locality. Researchers in China have come very close to meeting this high bar for three entangled particles.[424] Their results successfully utilize the high bar of Bell's inequality to prove three-way entanglement. What is more, researchers have shown that three-way entanglement may survive longer at non-zero Kelvin temperatures.[425]

Susskind has authored a paper which suggests that three maximally entangled blackholes or three blackholes connected with one wormhole is possible. The interesting thing about this configuration is that observing only two of these three blackholes will not be entangled. The entangled behavior occurs only when observing any one of the blackholes in union with the other two.

> Each blackhole is maximally entangled with the union of the other two, but there is no entanglement between any pair of blackholes.[426]

Susskind makes another interesting comment in this paper's conclusion.

> What is it that makes quantum physics so different from classical physics? Two things: first is entanglement; the fact that you can know everything that can be known about a system and know nothing about its parts. The second distinguishing property of quantum mechanics was pointed out by Feynman; namely the extraordinary potential complexity of quantum states.[427]

Multipartite entanglement

What is multipartite entanglement?

Bipartite entanglement is much of what has been discussed already. This is a simple case of two systems or particles entangled. Multipartite entanglement refers to quantum entanglement that occurs in systems composed of multiple subsystems. This would be the most likely case for *phusis*, for less pristine, environmentally isolated situations.

> Quantum theory does not prevent entanglement from being created and observed in macroscopic physical systems, in reality however, the accessible scale of entanglement is still very limited due to decoherence effects. Recently, entanglement has been observed among atoms from thousands to millions levels in extremely low-temperature and well isolated systems. Here, we create multipartite entanglement of billions of motional atoms in a quantum memory at room temperature and certify the genuine entanglement via M-separability witness associated with photon statistics. The information contained in a single photon is found strongly correlated with the excitation shared by the motional atoms, which intrinsically address the

> large system and therefore stimulate the multipartite entanglement. Remarkably, our heralded and quantum memory built-in entanglement generation allows us to directly observe the dynamic evolution of entanglement depth and further to reveal the effects of decoherence. Our results verify the existence of genuine multipartite entanglement among billions of motional atoms at ambient conditions, significantly extending the boundary of the accessible scale of entanglement. [428]

Multipartite entanglement is much more likely to decohere and recohere pluralistically with many systems in chaotic, less pristine, environments than more environmentally isolated bipartite entanglement. Unlike the simpler case of bipartite entanglement, multipartite entanglement involves more complexity and richness in the classification of quantum-entangled states. Multipartite entanglement of three or more quantum systems has some interesting characteristics. I want to simplify this by supposing that we have three observers of a tripartite (3 systems) multipartite system. Let's call each system Alice, Bob, and Charlie.

Each quantum system can have fully unentangled states. These systems are completely disentangled, meaning each subsystem can be described independently without any correlations to the others. Each of them is unentangled or separated from the others.

- Alice, Bob, Charlie are all living on their own classical branch. Each of them has no knowledge or entangled information of the others. [429]

Some of the quantum systems can be either partially or fully entangled with other systems. These states exhibit degrees of entanglement in some subsystems but not in others.

- On their entangled branch Alice, Bob, and Charlie have

all or some entanglement with the others. They are comingled entangled informationally with all or some of the others. [430]

Multipartite systems can be nonentangled or separable with respect to specific partitions. For example, a state may be separable when considering certain subsets of subsystems but entangled when considering other subsets.

- Alice can set up partitions administratively which dictate how Bob and Charlie can entangle with other systems. Physicists refer to administrative partitioning as steering multipartite entangled systems. Multipartite steering can be harnessed for secure quantum communication and cryptography. [431]

Multipartite systems can be partially entangled which means that they can also be separable under all possible partitions.

- If Alice, Bob, and Charlie can be partially entangled with each other, this also implies they can all be fully unentangled or separable from the others. [432]

A limit can be set on the number of entangled partitions where ‘s’ is the maximum number of partitions. This is called a s-Particle Entanglement. An s-particle system can have at most s-particle entanglements if it is a mixture of systems, each of which is separable with respect to a specific partition.

- Alice can set up a maximum number of partitions administratively which dictate the total amount of other entangled systems Bob and Charlie can have with other systems. [433]

A system of pure states in a multipartite system can be separable from the others if the entire multipartite system can be expressed as a product of individually entangled system states.

- If Alice sets up an ideal or close to ideal pure system and all the rest of the entangled systems can be a sum of products, a superposition, then the pure system can be unentangled or separable from the others. 434

Generally, pure multipartite systems are described as a spectrum of reduced density matrices of all the bipartite partitions.

- Generally, If Alice sets up an ideal or close to ideal pure system the mathematics can be simpler as a reduced set of matrices of all the partitions. 435

For mixed states, there is no simple necessary and sufficient condition for separability of the systems, but various criteria from bipartite entanglement can be generalized.

- If Alice sets up mixed systems, there is no easy way to partition all the systems. However, there are some general ways to characterize partitioning of the system. 436

I want to point out one specific example of how this works. Let's say Alice, Bob, and Charlie are all entangled with each other. When Alice gazes into her entangled abyss she can probe the quantum state shared among all three of them. Alice can steer partitioning by using measurement settings which are incompatible with Bob and Charlie. She can steer an entangled state between only herself and Bob. Only her and Bob have entangled information between them. Charlie is left out in the cold with no knowledge of Alice and Bob’s entanglement. Or Alice can steer an entangled state between only

herself and Charlie. Only she and Charlie have entangled information between them. In this case Bob is left out in the cold.

In Alice's view, our intrepid quantum explorer gazes into the entangled abyss. She can wield her measurement apparatus to probe the quantum state shared among the three of them. If Alice's measurement settings are incompatible, she can demonstrate bipartite EPR-steering to either Bob or Charlie. In other words, she can influence the state of one of her distant companions instantaneously. In Bob and Charlie's perspective, being the diligent entanglement sharers, have their own entangled secrets. They share an entangled state and harbor a local hidden entangled state. However, there's more to the story. The quantum cosmos reveals that:

- Bob and Charlie are entangled, but there's no direct entanglement between them.
- Alice can steer either Bob or Charlie, but not both simultaneously. If she focuses her quantum prowess on Bob, Charlie remains unswayed, and vice versa. 437

Researchers have developed one-step error-correction protocols specifically for multipartite polarization-entangled systems. These features are promising for practical applications in long-distance quantum communication. 438

Multipartite entanglement dances to its own quantum rhythm. Alice's influence, Bob and Charlie's entangled tango—it's a cosmic ballet where the steps defy classical intuition. 439

First Look at Virtual Particles and Vacuum Energy

When we think of subatomic quantum particles as waves, they are energy fields like waves in the ocean. They are timeless fluxes of pure energy which ebb and flow in and out of existence, take on form and order and instantaneously without regard to time and

space cease to have any meaning for the idea ‘to be’. Quantum particles, which are also fields of energy, are responsible for everything we have ever known. They make up atoms, forces of nature, molecules, rocks, metals, minerals, living animals, people, our brains…everything. They are even responsible for making the very fabric of space and time.

On the smallest scales of quantum particles, spacetime and everything in it is said to pop in and out of existence ceaselessly. On this level of really, really small, matter and antimatter will cause them to ‘be’ and not to ‘be’. They do not transform to something else like energy for example. They simply cease to be. This happens in the so-called ‘vacuum of space’ all the time and, seemingly very likely, in the singularity of a blackhole. It happens everywhere.

Quantum mechanics has found a few very specific ways to predict the behaviors of these particles when they bond and transform into matter. However, when they cease to exist as anything we would call ‘real’, physics refers to this as ‘virtual particles’. The ‘vacuum of space’ is not a vacuum but is filled with virtual particles. First, let’s forget the word particle.

> The best way to approach this concept, I believe, is to forget you ever saw the word “particle” in the term. A virtual particle is not a particle at all. It refers precisely to a disturbance in a field that is not a particle. A particle is a nice, regular ripple in a field, one that can travel smoothly and effortlessly through space, like a clear tone of a bell moving through the air. A “virtual particle”, generally, is a disturbance in a field that will never be found on its own, but instead is something that is caused by the presence of other particles, often of other fields.[440]

Let’s get into a little more detail. First, a bedrock assumption in physics is that the total energy of an isolated system remains constant. Another way to say that it remains constant is to say that

it is conserved over time. This is called the conservation of energy. Virtual particles violate the conservation of energy. How is this possible? Let's look at Heisenberg's uncertainty principle in terms of a particle's position and momentum. Written in words, it tells us,

> In 1927, Heisenberg formulated a fundamental property of quantum mechanics which said that it is impossible to measure both a particle's position AND its momentum exactly. The more precisely we determine one, the less we know about the other. This is called the Heisenberg Uncertainty Principle.[441]

However, this same principle is also written in words in terms of energy and time tells us,

The change of position times the change of momentum is equal to the reduced Planck constant divided by two.

It can also be stated as:

The change in energy times the change in time is greater than or equal to the reduced Planck constant divided by two.

> So, for a very short time, the uncertainty in the energy can be large. This leads into the idea of virtual particles. In many decays and annihilations, a particle decays into a very high energy force carrier particle which almost immediately decays into a low energy particle. The conservation of energy seems to be violated by the apparent existence of these very energetic particles. However, according to the above principle, if the time for a process is exceedingly short, then the uncertainty in energy can be very large. These high energy force carrier particles may exist if they are short lived. In a sense, they escape reality's notice. We can 'borrow' energy from the vacuum as long as we do it for a given time. The more energy we 'borrow ' the shorter the time we can have it. The bottom line is that energy is

> conserved. The energy of the initial decaying particle and the final decay products is equal. The virtual particles exist for such a short time that they can never be observed. Most processes among fundamental particles are mediated [or negotiated] by virtual carrier particles.[442]

The negotiation of neutron beta decay discussed above is a case in point of when virtual particles are used. Here is another way of explaining virtual particles:

According to a Scientific American article[443], quantum mechanics **requires** temporary violations of the conservation of energy. Virtual particles make it possible for an existent particle to become a pair of heavier, virtual particles which rejoin the original particle as if the virtual particles had never existed. This has been extremely well tested and quantum theory itself is founded on this process.

These virtual disturbances can violate the conservation of energy because they are short lived. Because they are so short lived, we refer to them as popping in and out of existence.

> Virtual particles are short-lived particles that cannot be directly detected, but that affect physical quantities—such as the mass of a particle or the electric force between two charged particles—in measurable ways. The existence of virtual particles is a purely quantum-mechanical phenomenon. The particles can appear out of nothing—the vacuum—only to quickly disappear back into the vacuum. Or they can be emitted by real particles, travel a short distance and disappear again as they interact with other particles. The Heisenberg uncertainty principle limits the duration of their fleeting existence and the distance they can travel. Virtual particles are both a curse and a blessing. A curse because their presence makes calculations of seemingly simple phenomena, such as the electric force between an electron

> and a proton, vastly more complicated. A blessing because their indirect contributions to subatomic processes can reveal new particles and forces that elude direct production by our highest-energy particle accelerators. Scientists have measured, for example, the contributions of virtual particles to the mass of the proton and to the attractive force between two metal plates. Experiments also identified virtual contributions from the Higgs particle, which is a key to explaining the origin of mass. Before the discovery of the Higgs, that information not only gave scientists confidence that it existed, but it also gave them a pretty good idea of where to find it.[444]

Einstein and de Sitter proposed a model of the universe in 1932, known as the Einstein-de Sitter universe, which assumed a vanishing spatial curvature as well as a vanishing cosmological constant. However, this model was later found to be inconsistent with the observed accelerating expansion of the universe. In 1917, Einstein had introduced the cosmological constant to the equations of general relativity to counterbalance the gravitational attraction of matter and keep the universe static. Later, in 1998, observations of distant supernovae revealed that the universe was actually accelerating in its expansion. To account for this, Einstein modified his original equations by introducing a new term, the cosmological constant, which represented the energy density of the vacuum of space. This modification allowed for the possibility of a universe that was not only expanding but also accelerating in its expansion. The resulting model is known as the Lambda-CDM model, which is the current standard model of cosmology. [445]

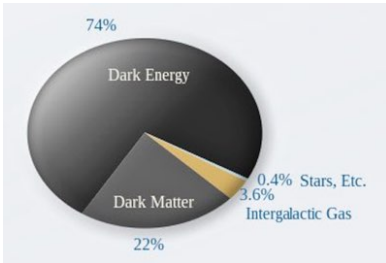
The cosmological constant was given by Einstein in general relativity as a necessary ingredient to account for the energy density of space.

Einstein gave the cosmological constant the symbol Λ

(uppercase lambda). Einstein stated that the cosmological constant required that 'empty space takes the role of gravitating negative masses which are distributed all over the interstellar space'.[446]

As mentioned, Einstein introduced the cosmological constant in his field equations for general relativity in 1917. He added this term to his equations to keep the universe static, neither accelerating nor decelerating, which he believed was the case at the time. However, later observations showed that the universe was expanding, and Einstein referred to the introduction of the cosmological constant as his “biggest blunder”. Initially, Einstein introduced the cosmological constant in his field equations, but he did not know that it would later describe the accelerating expansion of the universe. [447]

Much later, physicists believed the cosmological constant to have been very high soon after the Big Bang. This was done to account for the early hyper-inflationary period of the cosmos. This implies the cosmological constant was much higher before inflation than it is today.[448] Since vacuum energy density was very high prior to inflation random quantum jitter and fluctuations also had very high energy levels. After the inflationary period, the random quantum jitter and fluctuations were much closer to the extremely low levels of zero-point energy today. Additionally, expanding the size of a basketball to the size of the universe, which we see today makes our slice of the universe look very close to flat. All this implies that in our current slice of the universe, the cosmological constant has a very low positive level or the very slight geometric curvature in the expanding universe we see today.[449] The net effect is that all the ordinary mass, dark matter, dark energy, and the zero-point energy in the universe has to add up to the total energy density of the entire universe called critical density.



Critical Density of the Universe [450]

Critical density of the universe governs whether the universe expands like ours, compresses, or remain static.[451]

Effects of Vacuum Energy

Static electricity or the Coulomb force is another example of when virtual particles get elicited. Lightening is an example of the Coulomb force.[452] Static electricity is caused by the exchange of virtual photons. In symmetric 3-dimensional space this exchange results in the inverse square law for electric force. Since the photon has no mass, the coulomb potential has an infinite range. Virtual particles are the source of Heisenberg's uncertainty. If there were no virtual particles quantum mechanics could not exist and classical physics would be uncontested. I have included below examples which tell us about the necessity of virtual particles. Just as the yet unproven quantum of gravity called the graviton would be much too small to ever directly 'see' in the lab, we will never be able to find a virtual particle. We will only ever be able to surmise indirectly their hazy relationship with 'reality' due to the fact that quantum mechanics is essentially dependent on them. While I will not go into the technical details, some other field interactions which require the bookkeeping of virtual particles are:

> The Coulomb force (static electric force) between electric charges. It is caused by the exchange of virtual photons. In

symmetric 3-dimensional space this exchange results in the inverse square law for electric force. Since the photon has no mass, the coulomb potential has an infinite range.

The magnetic field between magnetic dipoles. It is caused by the exchange of virtual photons. In symmetric 3-dimensional space, this exchange results in the inverse cube law for magnetic force. Since the photon has no mass, the magnetic potential has an infinite range.

Electromagnetic induction. This phenomenon transfers energy to and from a magnetic coil via a changing (electro)magnetic field.

The strong nuclear force between quarks is the result of interaction of virtual gluons. The residual of this force outside of quark triplets (neutron and proton) holds neutrons and protons together in nuclei, and is due to virtual mesons such as the pi meson and rho meson.

The weak nuclear force is the result of exchange by virtual W and Z bosons.

The spontaneous emission of a photon during the decay of an excited atom or excited nucleus; such a decay is prohibited by ordinary quantum mechanics and requires the quantization of the electromagnetic field for its explanation.

The Casimir effect, where the ground state of the quantized electromagnetic field causes attraction between a pair of electrically neutral metal plates.

The van der Waals force, which is partly due to the Casimir effect between two atoms.

Vacuum polarization, which involves pair production or the decay of the vacuum, which is the spontaneous production of particle-antiparticle pairs (such as electron-positron).

Lamb shift of positions of atomic levels.

The Impedance of free space, which defines the ratio between the electric field strength $|E|$ and the magnetic field

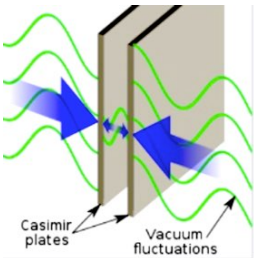
strength |H|: Z0 = |E|/|H|.

Much of the so-called near-field of radio antennas, where the magnetic and electric effects of the changing current in the antenna wire and the charge effects of the wire's capacitive charge may be (and usually are) important contributors to the total EM field close to the source, but both of which effects are dipole effects that decay with increasing distance from the antenna much more quickly than do the influence of "conventional" electromagnetic waves that are "far" from the source.[a] These far-field waves, for which E is (in the limit of long distance) equal to cB, are composed of actual photons. Actual and virtual photons are mixed near an antenna, with the virtual photons responsible only for the "extra" magnetic-inductive and transient electric-dipole effects, which cause any imbalance between E and cB. As distance from the antenna grows, the near-field effects (as dipole fields) die out more quickly, and only the "radiative" effects that are due to actual photons remain as important effects. Although virtual effects extend to infinity, they drop off in field strength as 1/r2 rather than the field of EM waves composed of actual photons, which drop 1/r. 453

Virtual particles are the 'vacuum' energy floor of spacetime. The 'vacuum' is not empty as classical physics assumes. It is like a noise floor of energy which is so low that the virtual particles can escape the second law of thermodynamics because they can only exist for extremely short times making them unmeasurable. The life spans of these energetic subatomic particles are so short that they are referred to as 'popping in and out of existence'. Some of these subatomic particles can be highly energetic. Think of these particles as extremely tiny bubbles. By themselves they have no noticeable effect in our universe. However, just like bubbles can combine into larger bubbles, these virtual pockets of energy can combine under

certain circumstances to have real world effects which do obey the second law of thermodynamics.

The Casimir effect is one real world proof that vacuum energy is real. The experimental setup for the Casimir effect is just like a capacitor.



Casimir forces on parallel plates

454

The only difference is that the parallel metal plates of the capacitor are much closer than a normal capacitor, a few nanometers apart, but still not touching each other. The plates are uncharged and no electric current or voltage is attached to the metal plates. There is nothing between the plates except vacuum energy. Yet, a mysterious force either tries to pull the plates closer together or pushes them apart. The force is believed to be related to virtual photons in zero-point energy. Since the plates are closer together than the wavelength of the virtual photons, there is a potential difference produced on the plates causing an attractive force or a repulsive force. What is most intriguing is that the geometry of the plates determines if the force is attractive or repulsive. Hemispherical plates produce a repulsive force. Spherical plates produce an attractive force. Additionally, microwave photons have been produced from vacuum energy in a dynamic Casimir effect which mimics an accelerated moving mirror at a relativistic velocity using a superconducting microwave resonator. 455

As illustrated above, the Coulomb force is a strong electrostatic

force. But this force is able to pull virtual particles from zero-point energy, vacuum energy, to create lightning or real matter. The ability to de-virtualize zero-point energy and re-virtualize zero-point energy leads to highly complex nonlinear interactive mathematics. This leads to the ability of gravity, spacetime curvature, to have an effect on light and at the same time light to have an effect on gravity or spacetime curvature.[456] Certainly, we see that the spacetime curvature of blackholes will not even allow photons to escape its grasp. Einstein even saw it in his lifetime when it was discovered that stars can bend light as he predicted. The bottom line here is that spacetime curvature, gravity, affects zero-point energy. Could it be that in our current universe, zero-point energy is very low due to the effect of gravitation?

> Physicists Richard Feynman and John Wheeler calculated the zero-point radiation of the vacuum to be an order of magnitude greater than nuclear energy, with a single light bulb containing enough energy to boil all the world's oceans. Yet according to Einstein's theory of general relativity, any such energy would gravitate, and the experimental evidence from the expansion of the universe, dark energy and the Casimir effect shows any such energy to be exceptionally weak.[457]

I find this very interesting as it seems to indicate that gravity, spacetime curvature, itself may have multi-dimensional aspects which M-Theory or brane theory mediates so that in our spacetime universe, zero-point energy is much weaker but still has a mediating effect on photons and gravity and vice versa.

> Both Einstein's theory of special and general relativity state that light should pass freely through a vacuum without being altered, a principle known as Lorentz invariance. Yet, in theory, large nonlinear self-interaction of light due to

> quantum fluctuations should lead to this principle being measurably violated if the interactions are strong enough. Nearly all theories of quantum gravity predict that Lorentz invariance is not an exact symmetry of nature. It is predicted that the speed at which light travels through the vacuum depends on its direction, polarization and the local strength of the magnetic field. There have been a number of inconclusive results which claim to show evidence of a Lorentz violation by finding a rotation of the polarization plane of light coming from distant galaxies. The first concrete evidence for vacuum birefringence was published in 2017 when a team of astronomers looked at the light coming from the star RX J1856.5-3754, the closest discovered neutron star to Earth.[458]

The astronomers discovered that light had undergone linear polarization of about 16% when it should have been no more than 1%. If this can be reconfirmed to the satisfaction of physicists, at x-ray lengths quantum fluctuations would be around 100%. There are telescopes coming on-line soon that will be able to measure these x-ray lengths. The Lorentz invariance violation being affected by quantum violations could be an indication of the existence of gravitons.[459] All of this would lead to more evidence that quantum gravity is finally the 'theory of everything' (probably).

Zero-point energy is the best explanation for dark energy as well.

> Dark energy makes up approximately 68% of the universe and appears to be associated with the vacuum in space. It is distributed evenly throughout the universe, not only in space but also in time – in other words, its effect is not diluted as the universe expands. The even distribution means that dark energy does not have any local gravitational effects, but rather a global effect on the universe as a whole. This leads

> to a repulsive force, which tends to accelerate the expansion of the universe. The rate of expansion and its acceleration can be measured by observations based on the Hubble law. These measurements, together with other scientific data, have confirmed the existence of dark energy and provide an estimate of just how much of this mysterious substance exists.[460]

Zero-point energy of the vacuum is the best candidate so far for explaining dark energy. The problem with this is that zero-point energy of the vacuum is absurdly large compared to the observed cosmological constant. Even according to relativity, this huge amount of energy should have ripped the universe apart. In 2023 the Euclid telescope will launch. It will tell us if dark energy has changed with time. If this is so, then the dark energy field is a scalar or a field which associates a number to every part of the field. If dark energy is found to be a scalar, it would not be related to the cosmological constant and thus, avoid the impossibility of the cosmological constant.[461]

A Deeper Dive - Another Look at the Quantum Wave Function and the Four Forces of Nature

When I write that 'a virtual particle is really a mathematics we call the quantum wave function' what I am conveying in a rather shorthand way is that virtual particles are required by the quantum wave function[s]. On one hand, it is a sort of mathematical bookkeeping which makes probability and uncertainty possible. On the other hand, virtual particles are part of that hazy middle I keep referring to which cannot be thought of as existent or non-existent. With that in mind let's explore the notion of virtual particles. A virtual particle is really a mathematics we call the quantum wave function. The quantum wave function describes the *process* of knowing at the current time, in the current branch, all *real*

possibilities; all ways which we have endowed as 'empirically observed' quanta coming into existence and out of existence. However, the quantum wave function is purely informational without recourse to essence. Essence is only made 'real' through its force in classicism's historic violence. The quantum wave function's form of information is what we call mathematical superposition. Mathematical superposition can be thought of as the possibility of all states, both observed and what exceeds the unobserved, the '**not**' of observed, for particular types of quantum phenomenon. Superposition describes states and permutations of quantum behavior which, when observed, branch into probabilistic descriptions of behavior.

> A quantum particle in a superposition, contrary to common belief, is not really in two (or more) states at once. Rather, a superposition means that there is more than one possible outcome of a measurement. For an object at everyday scales, described by classical physics, that makes no sense — it is either here or there, red or blue. If we can't say which it is, that's just because of our ignorance: We haven't looked. But for quantum superpositions, there simply is no definite answer — the property of "position" is ill-defined.
>
> If, however, we only see one outcome or the other when we look, how can we know the particle was in a superposition before we looked? The answer is that so long as we don't try to find out what the outcome is — so long as we don't measure that property — the two (or more) alternatives somehow embodied in the superposition can interfere with one another, just like two waves. This wavy behavior is embodied in a mathematical entity called the wave function, which encodes everything we are able to say about the particle.[462]

Increasingly, superposition has been used to describe more

complicated, larger interactions of nature. Initially, superposition and the 'simultaneity of all possible paths" was used to describe very limited small interactions with subatomic particles. Superposition tells us that a particle can be in many states simultaneously. In quantum field theory the three forces electromagnetism, strong and weak nuclear forces come about by the exchange of force-carrying particles called gauge bosons. Gauge bosons are created and destroyed in a process called quantum fluctuation. Superposition describes how gauge bosons can exist in multiple states simultaneously. These interactions allow particles to interact with other particles in ways which give rise to these three fundamental forces. There are experiments underway now which have undertaken the task of explaining gravity in terms of superposition.

> Attempting large quantum superpositions is a win-win situation, said Bose. If we find that physical collapse prohibits them, that would be a huge discovery about the fundamental nature of quantum mechanics. But if, as many suspect, physical collapse doesn't occur and the quantum world can just keep getting bigger, then big superpositions, with their extreme sensitivity to sources of decoherence, could act as very delicate sensors. The physicists Jess Riedel and Itay Yavin in Canada, for example, have proposed that quantum systems that are sensitive to gravitational effects might offer a way to look for dark matter particles, which seem to interact with ordinary matter only via gravity. Bose, meanwhile, is interested in using such systems as benchtop detectors of gravitational waves, which so far have only been seen with the aid of immense detectors several kilometers in size.
>
> In other words, expanding the quantum scale up to sizes where gravity matters might teach us new things about quantum mechanics, gravity and hidden aspects of the

> universe. The project will push technological capabilities to the limit, but the payoff could be enormous. And the current resurgence of interest in creating quantum phenomena such as superposition and entanglement on large scales is not a chance occurrence, said Arndt — because these are precisely what will be needed if we are going to scale up quantum computers so that they have many thousands or even millions of entangled quantum bits. "Quantum technologies will receive dozens of billions of dollars of investments in the coming years," he said, "and we had better understand the foundations of the theory underlying all these technological hopes."[463]

We have already seen that blackholes as highly entangled systems generate enormous amounts of gravity. But what about on the entangled qubits level? If enough qubits (quantum bits) were entangled, would that generate gravity? After all, as we will see entanglement could be explained by very tiny wormholes. Is there a number of entangled particles whose tiny blackholes joined by tiny wormholes could be detectable as gravity, as spacetime curvature? Are we back to the density question of entanglement? If the force of gravity can be explained in terms of large quantum systems, quantum gravity would then be the bridge to relativity and classical physics. There have been and will continue to be experiments which claim to observe this behavior. To date, these experiments are considered inconclusive by some physicists. But if entanglement *can* explain how gravity arises, we would have an association between entanglement and gravity or spacetime curvature. Oh, as an aside from our proofs, blackholes are already doing this so there must be a solution we will discover soon, hopefully.

In a latter section entitled the "The Standard Model of Elementary Particles" section we will discover that quarks are constituent of all four fundamental forces: electromagnetism, gravitation, strong interaction, and weak interaction. We will also

see that, "*The full wavefunction of any hadron must include virtual quark pairs as well as virtual gluons.*" Virtual particles are mathematically required by the time evolution operator of the wave function to explain perturbation, outside influences which are unexplained. In order to look more closely into the interaction of transitions, of time, between pure 'idealized' quantum states, we need the bookkeeping of virtual particles. Some working physicists see this as a kind of band-aid until we learn more about how these states are coupled. How could 'mathematical bookkeeping' pull virtual particles from zero-point energy to either pull or push the Casimir plates apart? The Casimir effect proves that by simply introducing two metal plates and an air gap an electromagnetic field can be pulled from zero-point energy to pull the plates together or apart depending on the shape of the metal plates. Virtual particles also play an important role in quantum tunneling where they can pass through potential energy barriers which standard particles could not get through. Physicists have a strong prohibition reaction to Newton's action-at-a-distance. Yet, the very notion of the word 'real' comes to the fore when thinking about virtual particles. Historically, some have referred to them as messenger particles.

> …in the 1988 Dirac Memorial Lectures of Abdus Salam, who systematically refers to the virtual particles which he, like others, calls "messengers" to reflect their role in mediating fundamental forces: "In quantum theory, all forces—whether gauge or non-gauge variety—are produced by an exchange of particles, which I shall call 'messengers' " ([13], p. 39) because, by serving as local agents mediating between scattered particles, these particles serve to uphold the prohibition of action-at-distance, something that is a problematic feature of the use of the classical Coulomb's law.

Because virtual particles are very short lived with Planck time lifespans, Planck sized energies, and uncertain mass if any. The main reason they are called virtual is because they can violate the conservation of energy due to their extremely transient nature.

> The following commentary from Steven Weinberg's 1977 article "A Search for Unity: Notes for a History of Quantum Field Theory" indicates the significance of the introduction of virtual particles by quantum field theory and addresses this as well as the issue of energy conservation: "It is important to understand that quantum field theory gave rise to a new view not only of particles but also of the forces among them. We can think of two charged particles interacting at a distance not by creating classical electromagnetic fields which act on one another, but by exchanging photons, which continually pass from one particle to the other. Similarly, other kinds of force can be produced by exchanging other kinds of particle. These exchanged particles are called virtual particles, and are not directly observable while they are being exchanged, because their creation as real (i.e., free) particles (e.g., a free electron turning into a photon and an electron) would violate the law of conservation of energy. However, the quantum-mechanical uncertainty principle dictates that the energy of a system that survives for only a short time must be correspondingly highly uncertain, so these virtual particles can be created in intermediate states of physical processes, but must be reabsorbed again very quickly". A crucial thing to note here is Weinberg's reminder of the caveat against strict, classical (i.e., zero uncertainty) enforcement of the equation (Equation (4), below) [energy-momentum relation - $E^2 = p^2 + m^2$] appearing in the conservation law—the grounds cited for "violation of the law of conservation of energy"—that in quantum theory is related to quantum energy indeterminacy, about which cf.

465

The reason the notion of ‘real’ is at stake here is because quantum field theory is not discrete packets of energy. It is wave-like where patterns of waves can be identified but like the ocean, these waves are bubbling, gurgling, foaming, etc. so all these transitions from recognizable wave-patterns we call ‘standard particles’ transition to other ‘standard particles’ or simply disappear altogether only to pop up in some perturbation as some other wave-pattern.

Zero-point energy can be thought of as a kind of energy stage where different actors, theories of quantum physics like quantum field theory, play out their drama. This is the uncertainty principle of Heisenberg where the position and momentum of a particle or wave cannot reside in a deterministic universe but must draw from a hazy middle which cannot be nothing and cannot be something. The cosmological constant necessarily has something to do with zero-point energy as it has something to do with vacuum energy density.

> vacuum energy density: Quantum theory requires empty space to be filled with particles and anti-particles being continually created and annihilated. This could lead to a net density of the vacuum, which if present, would behave like a cosmological constant. 466

If the universe were flat, the cosmological constant would be high enough to counteract the gravitational pull of matter and keep the universe from collapsing in on itself. A very high negative cosmological constant would not compress the universe into a singularity, but it could still lead to singularities. A very high positive cosmological constant would expand the universe more quickly towards the heat death of the universe. Since the universe is expanding, we believe there must be a positive cosmological

constant which repels a little faster than all the mass in the universe which attracts. However, all attempts to define its value have failed to find consensus by many orders of magnitude. [467] In addition to this problem, early on the static model's prediction of a vanishingly small cosmological constant was shown by Hubble to be incorrect. The cosmological constant was a term that Einstein added to his equations of general relativity to account for a static universe. However, when it was discovered that the universe was expanding, Einstein abandoned the cosmological constant and referred to it as his biggest mistake. But it still exists as a possibility -- a coefficient that should be determined from observations or fundamental theory.

> Einstein's Greatest Blunder
>
> However, there is a basic flaw in this Einstein static model: it is unstable - like a pencil balanced on its point. For imagine that the Universe grew slightly: say by 1 part per million in size. Then the vacuum energy density stays the same, but the matter energy density goes down by 3 parts per million. This gives a net negative gravitational acceleration, which makes the Universe grow even more! If instead the Universe shrank slightly, one gets a net positive gravitational acceleration, which makes it shrink more! Any small deviation gets magnified, and the model is fundamentally flawed. [468]

While zero-point energy is essential for physicists it is an embarrassment which they would like to sweep under the rug. Susskind devotes an entire chapter entitled “The Mother of All Physics Problems” to this embarrassment in his book “The Cosmic Landscape”.

> Is it really true that the universe and its laws are very delicately balanced? The second chapter, “The Mother of All

> Physics Problems," could also be called "The Mother of All Balancing Acts." When the laws of elementary particles meet the laws of gravity, the result is a potential catastrophe: a world of such violence that astronomical bodies, as well as elementary particles, would be torn asunder by the most destructive force imaginable. The only way out is for one particular constant of nature—Einstein's cosmological constant—to be so incredibly finely tuned that no one could possibly think it accidental. First introduced by Einstein soon after the completion of his theory of gravity, the cosmological constant has been the greatest enigma of theoretical physics for almost ninety years. 469

Zero-point energy is a kind of Buddhist *śūnyatā* meaning emptiness, vacuity, void, nothingness but more accurately 'fertile void'. A similar idea is embodied in the notion of *apeiron* as without limit or origin, boundless which can also more properly be thought of as 'fertile void'. This is the chaos of the earliest Greeks. At the beginning and end of the epoch of Being, this leads to a necessary kind of indeterminacy with regard to the historic notion of 'reality'. Could it be that the indeterminacy built into superposition cannot have a 'real' component? Are virtual particles the hazy excess of 'not-yet-existence' and the 'not of not-yet-existence' (the fertile void)? This might go a long way in explaining intrinsic and absolutely necessary uncertainty which may only have the spooky result of probabilistic behavior upon informational branching upon observation.

Entangled Spacetime Vacuum Energy

In classical physics, space is considered a vacuum and time is considered to be linear. However, spacetime is neither. Spacetime is believed to be stitched together by entanglement. This applies to the emptiest areas of spacetime.

> Even a perfect vacuum, which is defined as the absence of particles, will still have quantum fields. And these fields are always vibrating. Space looks empty because the vibrations cancel each other out. And to do this, they must be entangled. The cancellation requires the full set of vibrations; a subset won't necessarily cancel out. But a subset is all you ever see.[470]
>
> It is common to speak of a "fabric" of spacetime, a metaphor that evokes the concept of weaving individual threads together to form a smooth, continuous whole. That thread is fundamentally quantum. "Entanglement is the fabric of spacetime," said Swingle, who is now a researcher at Stanford University. "It's the thread that binds the system together, that makes the collective properties different from the individual properties. But to really see the interesting collective behavior, you need to understand how that entanglement is distributed."[471]

What is interesting about zero-point energy is that while the fluctuations are erratic and random, they seem to have matching segments of spacetime.

> But quantum fields are entangled — the fluctuations in one spot tend to match fluctuations in another spot.[472]

Tensor networks are used extensively in general relativity. For what are they used?

> The concept of vector should be familiar: a quantity for which both magnitude and direction must be stated. This compares with a scalar quantity, where direction is not applicable, like temperature in a precise point. But, what if the magnitude varies with the direction? A vector would be a particular case, with only one direction, but it is possible to

> think of quantities that have different values for different directions. Welcome to the world of tensors. [473]

This is a case of describing the forest by one tree or by all the trees. A vector only describes one instance of something somewhere, but a tensor provides a topological map, a function which takes you to any and all places on the map. Tensor maps have also become very useful in quantum physics. Tensor networks are mathematical tools for modeling the fabric of spacetime.

> Tensor networks provide a mathematical tool capable of doing just that. In this view, space-time arises out of a series of interlinked nodes in a complex network, with individual morsels of quantum information fitted together like Legos. Entanglement is the glue that holds the network together. If we want to understand space-time, we must first think geometrically about entanglement, since that is how information is encoded between the immense number of interacting nodes in the system…
>
> Similarly, entanglement seems to be fundamental to the existence of spacetime. This was the conclusion reached by a pair of postdocs in 2006: Shinsei Ryu (now at the University of Illinois, Urbana-Champaign) and Tadashi Takayanagi (now at Kyoto University), who shared the 2015 New Horizons in Physics prize for this work…
>
> "'What is spacetime?' sounds like a completely philosophical question," Van Raamsdonk said. "To actually have some answer to that, one that is concrete and allows you to calculate spacetime, is kind of amazing."[474]

The fabric of spacetime is highly entangled. However, spacetime itself is ripped apart by a blackhole. Even in Einstein's relativity the cardinal rule that information is preserved is affirmed.

> But almost everyone appears to agree on one thing. In some way or other, spacetime itself seems to fall apart at a blackhole, implying that spacetime is not the root level of reality, but an emergent structure from something deeper. Although Einstein conceived of gravity as the geometry of spacetime, his theory also entails the dissolution of spacetime, which is ultimately why information can escape its gravitational prison.[475]

Entangled Systems

Entangled particles can cease to be entangled or easily become entangled with other particles. Likewise, entire quantum systems can be entangled and become entangled with multiple other systems. One important point to note here is that while individual properties of an entangled system can be entangled, meaning that a particular property or a number of properties, have the same value regardless of spacetime, this does not mean the entire system, all of its properties, are entangled. Simply put, if I am an entangled system this does not mean another 'I' identical to me lives somewhere in another universe. This is Hollywood not science. Actually, it is impossible to know if all the different properties in entangled systems are entangled.

> Remarkably, quantum teleportation is the only way to transfer quantum information from one system to another without losing any part of it. It is absolutely impossible to measure all the properties of a quantum system and then send the information to a recipient who wants to reconstruct the system. This is because a quantum system can contain several versions of every property simultaneously, where each version has a certain probability of appearing during a measurement. As soon as the measurement is conducted, only one version remains, namely the one that was read by

> the measuring instrument. The others have disappeared and it is impossible to ever know anything about them. However, entirely unknown quantum properties can be transferred using quantum teleportation and appear intact in another particle, but at the price of them being destroyed in the original particle. 476

Moving on towards weirder, one entangled system can be divided up into parts which are separated from each other and still act as if they are one coherent system.

> It started with the mind-boggling insight that quantum mechanics allows a single quantum system to be divided up into parts that are separated from each other but which still act as a single unit.
>
> This goes against all the usual ideas about cause and effect and the nature of reality. How can something be influenced by an event occurring somewhere else without being reached by some form of signal from it? A signal cannot travel faster than light – but in quantum mechanics, there does not seem to be any need for a signal to connect the different parts of an extended system. 477

Another odd phenomenon is that we can take two pairs of entangled particles where one of the particles in each pair has already been observed so that the unobserved particles are entangled with each one of the observed particles in each pair. If these pairs of entangled particles are brought together in a special way, the unobserved particles of each pair can become entangled with each other.

> Once this had been shown experimentally, the next step was to use two pairs of entangled particles. If one particle from each pair is brought together in a particular way, the

> undisturbed particles in each pair can become entangled despite never having been in contact with each other. This entanglement swapping was first demonstrated in 1998 by Anton Zeilinger's research group. [478]

Entangled particles can cease to be entangled and so can systems. This is called 'sudden death'. There is also some evidence that previously entangled systems which became unentangled can be re-entangled. This is called 'sudden rebirth'.[479] Importantly, entangled systems can be partially entangled in nature.

> Entanglement can also occur among hundreds, millions, and even more particles. The phenomenon is thought to take place throughout nature, among the atoms and molecules in living species and within metals and other materials. When hundreds of particles become entangled, they still act as one unified object. Like a flock of birds, the particles become a whole entity unto itself without being in direct contact with one another.[480]

This quote makes an important point. Entangled systems lose their individuality and can no longer be analyzed as a sum of particles. The entangled properties are represented as a system. The existence of separate particles all acting to produce a summation of properties is not due to a lack of understanding on our part but due to the fact that individual particles no longer exist. Only the entangled system exists as an inseparable body. This has been labeled as 'intentional-like objects'.

> Let us recall Weyl's statement that one can't ask alibis of electrons. Dalla Chiara and Toraldo di Francia refer to quantum physics as 'the land of anonymity', in the sense that, on this view, the objects cannot be uniquely labelled (1993 and 1995). They ask, then, how can we talk about

> what happens in such a land? Their suggestion is that quantum objects can be regarded as 'intensional-like entities', where the intensions are represented by conjunctions of intrinsic properties. The extension of the natural kind, 'electron', say, is then given by the collection of indistinguishable elements, or a 'quaset'. The theory of such quasets then gives the possibility of a semantics for quantum objects without alibis.[481]

Partial entanglement means we can only have statistically probable information about the amount of entanglement between two entangled systems. Another way to think about two entangled systems is, we can only have more or less certainty about the entanglement of the two systems or more or less indeterminateness about the entanglement of the two systems. To the degree that quantum systems are entangled, we call that coherence.[482] When they cease to appear as entangled, we call that decoherence. Entangled systems can decohere, remain statistically predictable, or cease to be altogether entangled when they collide with other quantum systems. Since particles are waves of energy fields (potential differences of energy) physics has shown that even observing entangled particles may cause them to decohere. However, from coherence to decoherence they range from properties with identical behavior while observed to statistically decreasing predictable behavior. Entangled systems carry information such that knowing one entangled system tells us information about the other system, even if the other entangled system is on the other side of the universe. At times, entanglement happens nearby within a 'locality' as we commonly think about it, but it does not have to happen nearby. The classical notion of 'nearby locality' is what makes us 'think' classical physics works as well as it does.

A Scientific American article[483] tells us that entanglement and many quantum effects violate our most secure, commonsense

intuitions of the world. These effects even go so far as to violate Einstein's special theory of relativity. I highly recommend the reader read this article. The authors do a fantastic job of articulating the bizarre history of quantum physics to the present. I will try to paraphrase some of their discussion along with some of my observations.

We have what the authors deem an intuitive idea that fundamentally the universe, reality, is made up of objects which bump into each other. We push an object with our hand, it moves through space and time and collides into another object. The other object if not fixed will be 'touched' and respond accordingly. This is what I have termed simple common sense. The idea of cause and effect in history and science is determinant of how we fundamentally think of space and time. We simply think of this as 'reality', as what is fundamentally 'real'.

As the authors point out, even in special relativity we believe that nothing can go faster than the speed of light. But here again we imply an understanding of time as absolute (e.g., the speed of light). Certainly, Einstein's special theory of relativity proves in spacetime that the speed of light is an absolute asymptotic limit. However, by virtue of being an asymptotic limit nothing with mass can move at the speed of light. Only massless particles, what we think of as pure energy, can travel at the speed of light. So, light, photons, do not know anything about an asymptotic limit which can never be approached. Photons always travel at the speed of light. But for particles with mass this is an asymptotic limit they can never reach. Reality is always asymptotic for us. History is the absolute domain of a limit we can never reach. However, the domain which 'lives' so to speak at the limit of the speed of light is radically different from everything we and history have simply assumed.

The speed of light is an absolute limit from our relative perspective. Relative to us, time slows down as anything approaches the speed of light. And at the perspective of pure energy time stops. Since relativity shows that space and time are different ways of

observing the same phenomenon this means at the speed of light space is no more. Massless particles never see our universe!

From the perspective of massless particles, such as photons (which are particles of light), the universe appears quite different due to their unique properties. Massless particles, like photons, always travel at the speed of light in a vacuum. This means that they experience no time delay as they move through space. From their perspective, the entire universe is "compressed" into a single moment. Since massless particles have no rest mass (their mass is zero), they don't experience gravitational forces in the same way massive objects do. According to Einstein's theory of general relativity, massive objects (like stars and planets) curve spacetime around them. Photons follow these curved paths, which we perceive as gravitational lensing. However, for purposes of illustration, from the photon's viewpoint, it simply travels in a straight line through this curved spacetime. More exactly from a photon's perspective, they never even 'see' our universe.

Quantum mechanics introduces another layer of complexity. Massless particles can exist in a superposition of states until observed. This means that a photon can simultaneously be in multiple places or states until it interacts with something (like a detector). Until then, it doesn't "see" the universe in the same way we do. Keep in mind that particles don't "see" or "experience" the universe as conscious beings do. These descriptions are analogies to help us understand their behavior based on physical laws. Massless particles perceive the universe in a fundamentally different way due to their properties. While we observe the universe through our senses and instruments, photons traverse it without experiencing time or gravitational effects as we do. [484] What the authors of the Scientific American article bring out directly addresses how our history, including the early stages of quantum physics, wants to impose itself on us as if anything else would simply be ludicrous. But that is exactly where we need to start our initial visit to quanta and massless particles.

If we really want to let quantum physics speak to us, we need to suspend fundamental and common unquestionable 'truths' which have become determinant of what simply 'is'. Quantum physics tells us that one thing touching another thing is a fiction we have entertained from our history. Quantum physics' entanglement was 'spooky' according to Einstein. And yes, it is spooky according to conventional reasoning. But what we really need to do is bracket, set in parentheses, the spook factor and suspend this knee-jerk reaction to reality, to the real.

As the Scientific American article reveals we can think of quantum physics as an aberration, a weird marginal quirk of the extremely small or let the current volume of work in quantum physics inform us that we are facing an exteriority which finds no place in what we think we know for certain. Quantum physics' entanglement is not a supplement but "*the characteristic trait of quantum mechanics, the one that enforces its entire departure from classical lines of thought*" according to Schrödinger. What does this imply?

Things do not touch each other 'locally'. Locality is a historic presumption of what is fundamental, of historic narrative simply taken as 'what really is'. Quanta has no precise location. Quanta can take on a location, a measurement, upon observation. Quanta's entangled partners, whether particles or systems, can have nothing to do with our reality, our universe, our observer-effect notions of space and time. Yet, upon observation of entangled quanta, quanta's non-existent partners can mirror our observed state. This timeless/placeless mirroring has nothing to do with what we deem reality.

What has also become apparent in quantum physics is that time is no different than space or locality. Time and space are a visceral effect of observation not an underlying reality. Entangled particles or entangled systems do not react 'faster than the speed of light' or even 'instantaneously'. They react as if time does not exist at all. It is as if time is a supplement imposed by our observation and given voice by our language, history, and determinant narratives.

Nietzsche discussed a ‘revaluation of all values’. But here we are directly addressing the very field upon which all ‘values’ form, find reason, and take up significance and meaning. And this does not imply the binary dualism of values as meaningless, ancillary or a function of what Nietzsche deemed “willing it thus”. This means the object, our assumed relationships’ claim to origin, to divine authority, to absolute completion has no fundamental basis in our histories of reason (epistemology) or historic *isness* (ontology). Here we are left to face radical alterity in which none of these categories find historic impositions.

The Scientific American author’s argument ends with the notion of GRW theory (Ghirardi–Rimini–Weber theory) or otherwise called spontaneous collapse theory. This idea is believed to do away with all the naive and solipsistic imputations cast upon the ‘observer effect’. The observer effect may be imagined as if someone simply invents reality when they observe it. It is as if the universe, the self, history, the Big Bang all happen every time each one of us observes it. GRW theory remains fixed in the quantum wave function and entanglement. GRW theory maintains the nether world of the quantum wave function as systems in the wave function are neither ‘possibilities’ nor ‘realities’ but defy such categories. However, GRW theory tells us that these systems in which the observer is yet another entangled system in the wave function can spontaneously localize/temporalize themselves. What are the profound implications of this?

The observer is not an isolated self, standing apart from the nether world of the wave function or an object being acted on by other entangled systems in the wave function. The observer in cohabitation and along with other entangled systems is able to spontaneously localize/temporalize/historicize myself/themselves. What is astonishing about this is that all the certainties of objectivity and subjectivity no longer suffice. And neither does Hegel’s Concept as evolving find or be founded upon any absolute ground, fulfillment of itself, in which to stand on. This is not an

either/or nor is it none of the above. There is radical alterity upon which actualization or idealization, nor the 'not' of each or both, as reason and logic might dictate. This is an unbreachable abyss which cannot lapse into lethargy or contempt but, as I and Levinas would maintain, can only call forth responsibility. None of this can stand in an absolute or a 'not' of the absolute but in *response* which is not optional. More on that later.

Entangled Density: The 'is' of Distance

As mentioned in the last section, humans simply assume that moving something like a rock means we have to touch it or perhaps touch it with something else like a stick or perhaps ask someone else to move the rock. We simply assume that movement itself involves a sequence of cause-and-effect operations which happen locally. But this classic assumption of 'nearby locality' may have a very different meaning than what our history tells us.

For quantum entanglement the notion of linear space in terms of near and far is meaningless. This appears to violate classical physics which was built around absolute space as linear distance. Quantum entanglement itself has no sense of near and far. It does not know anything about locality which makes it seem like it prefigures space and time in some odd way. However, let's think about it backwards from the way we customarily think about it. What if the density of entanglement particles in systems statistically determine proximity to each other not distance? In this case, the higher the density of entangled systems, we associate that as closer. The lower the density of entangled systems, we associate that as farther away. So near and far is no longer determined by distance but by entangled density. Entangled density is not correlated with distance as we normally think about it, but it does vary immensely. Entangled density in the singularity of a blackhole is vastly higher than other areas we think of as 'space'. However, the correlation of what we normally think of as spatiality being 'local' may be a purely historic

narrative that we tell ourselves. We have an abstract historic notion of near and far as linear distance. But it may well be that we have contrived a historic metaphysics which 'makes sense to us' as 'real' but physics may be telling us that near and far have an entirely different basis. Here is an excerpt from an interview Sean Carroll has with Steven Strogatz. Sean authors books on physics and philosophy. Sean is Homewood Professor of Natural Philosophy at Johns Hopkins, and also Fractal Faculty at the Santa Fe Institute. Steven is the Jacob Gould Schurman Professor of Applied Mathematics at Cornell.

> …I think of the wavefunction as the fundamental thing, right? I think that's what exists in reality. And the wavefunction, like the wavefunction of this positron and electron is utterly nonlocal. It just exists all — it's a, it's a feature of the universe as a whole right from the start. So, I also have a mystery to be explained, but my mystery is the opposite way. It's not "why is locality approximately or, you know, seemingly violated by entanglement?" It's "why is there locality at all?" Like, that's the puzzle to me…
>
> We just have an abstract quantum wavefunction and we're asking, can we extract reality as we know it from the wavefunction? Space-time, quantum fields, all of those things, okay…
>
> And then what you can do is take two different points of space-time, at some distance between them, and because there are still *things* there, because there still are fields even in empty space, you can say, is there entanglement between these two points of space? Because of the fields there. Are the — is the quantum state of the fields at these two points in space, is it entangled? And the answer is yes, it is always going to be entangled…
>
> And in fact, more than that, if the points are nearby, the fields will be highly entangled with each other. And if the

fields are far away, the entanglement will be very, very low. Not zero, but very, very low. So in other words, there is a relationship between the distance between two points and their amount of entanglement in the lowest-energy state of a conventional quantum field theory…

And what we say is, look, we start with an abstract quantum wavefunction. We don't have any such words like distance, or fields, for that matter, right? But we do have the word "entanglement." We can figure out, if you divide up the wavefunction into this bit and this bit, are those two bits entangled? There's mathematical ways to measure them using the mutual information, etc. So you can quantify the amount of entanglement between different pieces of the wavefunction. And then, rather than saying "the more distance, the less entanglement," you turn that on its head. You say, "Look, I know what the entanglement is." Let me assume, let me put out there as an ansatz [a mathematical assumption], that when the entanglement is strong, the distance is short. And I'm going to define something called the distance. And it's a small number when the entanglement is large, it's a big number when the entanglement is small. [485]

There are so many fundamental and philosophical implications of this notion of distance which phenomenology around the time of Einstein began to work out which would go a long way towards validating this very different physics of near and far. I will go into this later, but for now, we can no longer assume the historical baggage of objective, abstract linear space as measured by a ruler and time as a linear progression of 'now' moments. Even more there is an interactivity of time and space which is authenticated more concretely as lived time and lived space by the entangled and incessantly entangling physics of near and far.

This might have relevance as well in terms of what we might

think of as interactions with others, people, animals, the environment, lived regions we inhabit. In our lived experience we do not inhabit an abstract, neutral world where we simply exist as some kind of automatons. We bring varieties of feeling and settings near and far. In phenomenology this is called disseverance. An example that may make this clearer is a person who is wearing glasses and looking at a painting. Physically, the glasses are closer to the viewer, but for the person absorbed in the world and looking at and contemplating the painting, the painting is closer: "the objective distances of things present-at-hand do not coincide with the remoteness and closeness of what is ready-to-hand within the world". Another example of disseverance is when a nurse makes a conscious effort to connect with a patient, choosing to remove the distance between their shared humanities. Directionality creates a spatial involvement and occurs within a region of ontological concern, where we have already decided something ready-to-hand (*zuhanden*) (of immediate usefulness). 486 The way we do this in lived experience is a form of lived space not abstract linear space. Quantum physics has not reached this level of understanding how this might happen to humans and perhaps other animals as well. But as mentioned we are making headway with finding in magnetoreception and heartbeat-evoked potential (HEP) in our brains. There are other examples I will give later. But surely, we can imagine that on the surface, entangled and entangling systems in the quantum wave function could collapse into how we live space through disseverance.

Could it be that all our historically inherited notions of 'practicality', desire, and need might be entangled and entangling modalities of how we live the world, on a level unimaginable to our commonsense notions of space as mere abstract linear distance. If so, understanding entanglement may change our commonsense notions of abstract distance. The notion of linear distance we tell ourselves may be hopelessly entangled from an abstract version of history and language and culture which pits us against more

concrete lived experiences. We do not live as robotics where distance is calculated and orientation to the environment is a result of calculations to objects. We have entangled and entangling relations with others, to political ideologies, to religious doctrines, etc. Classic science condemns to a reduced set of spatially lived experiences in our historic abstractions which do not comply with how we actually live space. History wants to box us into a certain approach, a disposition, which assumes too much, objectifies too much, and ultimately entraps us into figments of our imaginings which justifies reductions to narcissism where we only become capable of hearing our own echo over the canyons of abstract distance.

Perhaps entangled systems can have a different type of proximity to each other. Perhaps entangled systems are oblivious to our classical notions of 'nearby' and 'far away'. Entangled information is pre-time and space, pre-originary. By establishing how classical spacetime emerges, branches from entangled systems in the quantum wave function we have achieved a probable predictability which has no absolute footing or basis in our imagined absolutes and essences. In the wave function entangled systems combine the advantages of pre-spacetime entangled information with decoherence in the observer effect and therefore a spooky kind of relevance as spacetime. Predictability is information which is usable and useful but perhaps not in the way commonsense informs us. When entangled systems are no longer entangled, when they decohere, they have no predictable behavior or meaning information relative to the wave function. But we live the wave function in all our branches decohering into the 'is' of now which combine into history and my history, meaning, significance, and choice. Our branching with our histories presents us with choices of how 'reality' is conditioned, interpreted, and justified. If we choose to condition, interpret, and justify ourselves over and against the other we fall into an echo of ourselves to ourselves without relation to externality and alone in an existential

void of petty gamesmanship. But in the wave function continues on remaining coherently entangled and entangling. It remains an uncertain other than 'me' in entangled information lost to 'me'.

Entangled Observation: The 'is' of Time

The way we experience time is not the abstraction we believe is time. When we are happy 'time flies by'. When we are depressed 'time drags on so slowly'. We feel the tug of time, the stretch of time every day. We 'never have enough time'. Could it be that the way we live time and the way we think time as a linear succession of 'now' moments are incongruent? Furthermore, if we think of time as the abstraction of linear 'now' moments that also is an 'observable' which can branch off as a history of information from the quantum wave function. We say we are 'slaves to the clock'.

First, a state is an idealized notion of a 'pure state' which is thought of as a statistical possibility of a rigidly controlled experiment. In Schrödinger's wave equation there are unitary evolving states which are snapshots of possibilities. This is called parameter-time.

> The parameter-time is the time over which the system's state unitarily evolves. It is represented by the variable t as it appears in the Schrödinger equation.[487]

But this is an extrinsic time measured by the clock. If we have a known state 'x' under certain strict conditions set up by rigid experimental conditions, in other words measured by a very specific and strictly controlled 'observable' (e.g., the clock), we can predict over many statistical trials with a level of uncertainty, how a transition to another known state 'y' will evolve using the standard notion of a very accurate clock. The clock is not in any way tied to the apparatus of the experimental setup which would directly contact the quanta being studied. However, in my way of thinking,

this can be thought of as a bit of a hazy external time. Why?

On the face of it, we might be tempted to think that once we arrive at a statistical probability of how 'x' evolves in clock time to 'y' we can simply universalize it as what is the case, how it will typically evolve using the same ticks of a clock, how it will achieve some sense of objective reliability. But all this is bringing classical understanding into a non-classical world. 'The same ticks of a clock' may bring more or less statistical probability in similar rigorous experimental conditions. This is a good thing because it gives quantum physics a certain amount of predictability and distinguishes itself from metaphysics. But quantum mechanics based on its own rigorous proofs cannot provide *carte blanche* any objective reality in a classical sense.

Quantum mechanics cannot in principle go that far because there is no object, underlying reality to which quantum mechanics must comply with when we are not looking, observing, measuring. Effectively, there is one important observable which can easily fly under the radar for parameter-time – that is the clock. In using the clock, we import another observable if you will, clock time as an intrinsic part of the observable. You can see how, already in parameter-time, we have set up, as an important part of the experiment, another external parameter, a clock, which intrinsically becomes part of the probability of an outcome upon observation of results. In quantum mechanics we can no longer assume or believe that the clock is an objective measure of what is evolving or happening. The clock is caught up with the unitary evolution function. This is why we need another parameter in the Schrödinger wave equation, the event-time.

> The event-time is the time at which particular events occur. Those events are measurement results or, more generally, any acquisition of a definite value by a certain observable.[488]

Event-time as a variable in the Schrödinger wave equation is not

based on clock time but events which transpire that cannot find a stable clock time from which prediction can find statistical significance. Again, in my way of thinking, this can also be a hazy form of intrinsic time. Think of event-time as a way of idealizing that if one event occurs there is a statistical probability that another event might occur, without any way to predict when the event will occur, again under very rigorous experimental conditions.

One important thing to remember about Schrödinger wave equation is that the entire universe is part of the equation. There is an excess, an infinity, to the wave equation which cannot be accounted for but only truncated as information updates feed back into themselves to recreate, at least analogously thinking, many-worlds branching off never to return to an origin. The only alternative would be Laplace's demon which, in an idealized sense or an absolute God-like sense, would finitely resolve all information updating into metaphysical totality. In Levinas' sense this totality could only be achieved as a retreat from radical alterity…as we will see later, the face of the other. In a post-modernist philosophical position, we might think of all this uncertainty, indeterminacy, and the universe of observables feeding back into itself as an infinite reduction of a repetition of itself resulting in an erasure of its trace, its origin. Like the mystic writing pad, when you pull the plastic up there is still an imprint on the pad under the plastic but from a psychological perspective only retained by the unconscious as an imprinted trace. In postmodernism itself one way this trace might show itself is as the incessant requirement that the signifier always rise up, yet again, into a signified. But just as we already saw, every time we recall an event our memory of it changes slightly and is reconstructed neurologically with each recall. We never have an original memory, a stable origin. There is only a trace which gets reconstructed as a new narrative, of memories, feelings, and concerns. Or this is yet again analogous to the way that Schrödinger's wave equation incessantly feeds back into itself as many-worlds branching and updating.

With all this in mind, how would time show itself as *phusis*? It may be that it will never show itself as physics, as reducible to some purely physical, elementary particle or process which gives rise, provides origin, to temporality. It seems that there is increasingly more evidence against any possible discovery of the time wavicle. That seems to me to harken back to a classical 'need' for an objectivity to time. Why are we asking for an objectivity to time when we have already given up on an objectivity to 'reality'? Perhaps we need to simply wake up and smell the coffee after a delirious history of overdoing the spirits. The closest I see to a sense of time is Schrödinger's wave equation in concert with Heisenberg's uncertainty principle. Our observables as lived time, as wave function endlessly branching information updates, prohibits origin and promotes an externality from which we cower into the imagined security and promise of history and Being.

Entangled Systems, Entropy, and Information

Classically, any 'thing' like a bar stool, a molecule, or a human body is what physics calls a system. Moreover, absolutely any 'thing' is a quantum system. A system is a body which is composed of atoms which are constructed of subatomic particles. Thus, entanglement happens extensively in systems. Entanglement in systems does not mean that all the system's properties are absolutely entangled as is the case for artificial, laboratory cases of two quantum particles. Systems can be partially entangled as they are composed of mixtures of entangled systems and unentangled particles or unbound particles. The ambient environment is always interacting with entangled systems causing them to change. There are two types of entropy, the classical entropy we know and love (not) and quantum entropy which is really a measure of how entangled the quantum wave function is for a particular observation. Quantum entropy is one primary way entangled systems change. Physics can statistically quantify the overall effect of how entangled systems are

and how entangled systems over a statistical spectrum might respond to a given stimulus such as a burst of energy. These predictions can be highly accurate but are heavily computationally massive with our current bipolar computer technology.

Quantum computing, which is already here and on the near horizon for the mass market, will address the computational complexities of quantum mechanics and systems. Since entanglement is phenomenologically oblivious to spacetime, its behavior is described in purely informational terms. In this case, the idea of information does not necessarily have anything to do with cause and effect, spacetime. Information in this sense may have no cause, no prior antecedent in spacetime. Entangled information is prior to spacetime and cause and effect.

With these considerations in mind, I will utilize the notion of 'self-caused' to mean in the specific case of quantum entanglement, the act of observation or measurement collapses 'virtual' information in the wave function into classical 'reality'. Entangled information is the properties of entangled quantum systems which mimic each other instantaneously no matter how they are separated in spacetime. Entangled information is the notion of complexity rising up from 'cause' and 'uncaused' (the 'not' of cause) passing from the limit into chaos, specifically referring to quantum entanglement as spooky behavior, alien to cause and effect and spacetime. Furthermore, even the temporal-spatial act of observation branching from the wave function does not easily reside in epistemological or ontological categories. Entangled information can be thought of as atemporal and aspatial. We know quantum entanglement occurs in the wave function as a statistical predictor of phenomenal behavior. We have proven this observational behavior in part using high energy, particle accelerators.

However, entangled information is fundamentally different from the kind of information classic physics assumes which always has an informational predecessor, a cause. The interaction between

entangled systems or particles interacts not based on temporality. It happens instantaneously. Classical cause assumes time and space are absolutely deterministic. That is, any event is predicated by some other known event. This is classical physics. Classical physics could be thought of as a limited case of quantum physics given certain assumptions, i.e., absolute time and space etc. Contrarily, quantum entanglement as a wave function phenomenon can classically predict statistical information of behavior with regard to events in time and space but has nothing to do with some kind of underlying mechanistic cause which propagates through spacetime. This kind of information is very different from other uses of the term 'information'. Perhaps, this sense of information is similar to what Kant might call categories of understanding.

Quantum Foam

John Wheeler's theoretical concept of quantum foam describes the fluctuation of spacetime on very small scales. It predicts that particles of matter and antimatter are constantly created and destroyed, forming subatomic objects called virtual particles. These virtual particles are believed to exist for only a brief moment before annihilating each other.

> At the quantum level, matter and antimatter particles are constantly popping into existence and popping back out, with an electron-positron pair here and a top quark-antiquark pair there. This behavior is the reason that scientists call these ephemeral particles "quantum foam": It's similar to how bubbles in foam form and then pop. [489]

The bubbles in the quantum foam are quadrillions of times smaller than atomic nuclei and last for infinitesimal fractions of a second.

The idea that space is a bubbling brew of ephemeral particles sounds like complete nonsense, but the idea has been confirmed. In 1948, a physicist named Hendrik Casimir realized that if you placed two metal plates near each other, separated by a very small distance, the quantum foam would cause them to move. To visualize this, remember that quantum particles are also waves. Between the plates, only waves (particles) with wavelengths smaller than the separation between the plates can exist. Outside the gap, waves (particles) of all wavelengths can exist. Thus there are more particles outside the gap than inside, and the imbalance pushes the two plates together. This effect has been observed.

Another well-known manifestation of the quantum foam will be studied by Fermilab's proposed Muon g-2 experiment. The muon is a charged particle with a spin of 1/2, and a spinning charged object is a magnet. It is easy to calculate exactly what the strength of the muon magnet should be. When the magnetism of the muon was measured, it was found to be off from the prediction by 0.1 percent—a significant amount, caused by the quantum foam. Physicists are able to calculate the effect of the quantum foam on the muon's magnetism, and it agrees with the theory to incredible precision, better than a part in a billion. The same effect has been seen for electrons as well. This is one of the most precise measurements particle physicists have made and is excellent confirmation of the idea of the quantum foam. On the other hand, there is still a residual discrepancy between the measurement and calculation of the muon's magnetism, which the Muon g-2 experiment intends to study. It may be that the experiment's outcome will change our understanding of the quantum foam, though there are other possibilities.

The quantum foam is real. The microcosm is in continual

> motion. Scientist J.B.S. Haldane's aphorism is true: "The universe is not only stranger than we imagine, it is stranger than we can imagine." [490]

Some physicists have suggested that the fluctuations in spacetime caused by quantum foam could lead to a breakdown of the notion of time at the smallest scales. This is because the very geometry of spacetime fluctuates over sufficiently small distances and brief intervals of time, according to John Wheeler's hypothesis. While the idea of quantum foam is still being researched, it is not yet clear whether it has any direct connection to time. However, some theories suggest that the uncertainty principle could imply that over sufficiently small distances and brief intervals of time, the "very geometry of spacetime fluctuates". These fluctuations could be large enough to cause significant departures from the smooth spacetime seen at macroscopic scales, giving spacetime a "foamy" character. While there is no direct evidence that quantum foam has a direct connection to time, it is an interesting concept that is still being researched by scientists. [491] Quantum foam bubbles are a result of the quantum fluctuations of spacetime, and while they do not directly relate to temporality, they could have implications for our understanding of time at the smallest scales. [492]

Kant's Categories of Understanding

Categories of understanding were *a priori* for Kant. What he meant by *a priori* was prior to experience, sensation, empirical evidence, or motion in Aristotle's sense. *A priori* is prior to cause and effect in common vernacular. We could think of *a priori* as not related to time. Kant's categories of understanding and subcategories in parenthesis were, quantity (unity, plurality, totality), quality (reality, negation, limitation), relation (inherence and subsistence (substance and accident), causality and dependence (cause and effect), community (reciprocity), and modality (possibility,

existence, necessity). Kant, himself, did not state how these *a priori* categories of understanding came about. It was more like a phenomenological observation based on his logic of analytic and synthetic judgements.

> Kant's assumption was that our forms of intuition and our categories of thoughts constitute the transcendental conditions for the possibility of any objective experience. Thus, space and time are referred to as the forms of intuition, and the categories of understanding such as causation, unity, plurality, and totality are the a priori concepts which the mind imposes on the sense impressions that appear in our intuition.[493]

Kant thought any claim that was necessarily true, which philosophy calls tautology, must be *a priori*. We could even think of some philosophers like Leibniz as having thought of identity as *a priori* in regard to his notion of monads.[494] Leibniz writes of monads as,

> "Any mass contains innumerable monads, for although any one organic body in nature has its corresponding [dominant] monad, it nevertheless contains in its parts other monads endowed in the same way with organic bodies subservient to the primary one; and the whole of nature is nothing else, for it is necessary that every aggregate result from simple substances as if from elements". In other words, each monad will have an organic body which is in turn composed of other monads, each of which likewise has an organic body. Similarly, any seemingly inanimate chunk of matter – a stone or, yes, a drop of urine – will be the result of an infinity of monads and their organic bodies, which are nothing more than more monads and their organic bodies. This view is associated with a panorganicist strand of Leibniz's thought.

> And it is for this reason that Leibniz will claim that "all of nature is full of life" and that "there are infinite degrees of life in the monads".[495]

Monads were self-contained. They had no exteriority. They were self-caused reminding us of Aristotle's unmoved mover and information.

> here is … no way in which it could make sense for a monad to be altered or changed internally by any other created thing. Because there is nothing to rearrange within a monad, and there is no conceivable internal motion in which it could be excited, directed, increased, or diminished, in the way that it can in a composite, where there is change among the parts. Monads have no windows, through which anything could come in or go out. And accidents cannot detach themselves and stroll about outside of substances, as the Scholastics' sensible species used to; so neither substance nor accident can come into a monad from outside. [496]

We can see the effects of Kant's categories of understanding in experience but the categories themselves came prior to time and space or motion. Cause and effect themselves were a category of Kant much like entangled information in the special sense we are thinking of as non-causal, prior to time and space, 'information' observed arising from chaotic, quantum foam as entangled systems to statistically predictable behavior in time and space.

Exformation Introduced

Henceforth for clarity, we will call this different kind of entangled information '**exformation**'. Here the prefix '*ex*' in ancient Greek means 'governs the genitive' or governs genesis, origin, motion, cause and effect, etc. However, the oddity of 'what governs genesis'

knows nothing about ‘origin’. In this case, ‘*ex*’ also carries with it the more modern sense of externality or in our case radical externality. For the sake of this book, exformation will be exclusively used to mean the peculiar kind of ‘information’ retained by quantum entanglement. In this book the normal use of the word ‘information’ will mean any kind of information including exformation (entangled information) as it is normally used in physics. Exformation will uniquely specify entangled information which has no locality. Branching or state reduction as the observer effect loses wave function information due to decoherence. This loss of information results in an observed value, a measurement. Our experience of temporality is a result of the observer effect falling, branching, collapsing as classicism. However, the quantum wave function itself is not fazed by our experience, what we think of as reality, due to the observer effect. The quantum wave function has always already a-temporally, think of as simultaneously, anticipated our influence in superposition. But relative to our perspective our falling into classicism has precluded us from access to quantum wave function information. We will have to let our classically informed ‘neutrality’ of the word ‘information’ take an alien, unaccustomed tone. The implications of this are startling from our historic point of view.

Information inclusive of exformation has an uncertain relationship to epistemology and ontology in the quantum wave function and also in the loss of information we perceive resulting from the spooky observer effect, our branching as state reduction. The quantum wave function is oblivious to our state reduction, our experience of reality, of classicism. Quantum wave function information remains intact without regard to our ‘experience’ as we imagine it from the history of classicism. Our ‘experience’ is informational loss from branching. We experience informational loss as a limit, e.g., imposed by spacetime. However, in the quantum wave function itself information, already including our ‘experience’, is just another term already taken account of in

superposition. From the quantum wave function's perspective all such terms as we, me, reality, experience, the 'here' of 'me' remains informationally chaotic in what we can only think of as the universal[497] wave function. Normally we are accustomed to thinking of spacetime as primary and exformation must somehow fit into that temporal scheme. But spacetime from our perspective emerges chaotically from information where exformation is not "***one [property of quantum mechanics] but rather the characteristic trait of quantum mechanics, the one that enforces its entire departure from classical lines of thought***". [498] Therefore, emergence in this sense is very different from the classical notion of emergence as it is not an effect of prior causes. The assumption that emergence is necessarily tied to causality is a modernist mechanical model inherited from classicism.

I call this assumption the Frankenstein model not after Victor Frankenstein's creation but after Victor Frankenstein himself who was the real monster of the tale. Victor Frankenstein's creation introspectively called himself 'monster'. But Victor Frankenstein had no introspection of himself. Victor Frankenstein's creation says to *its* creator, "I ought to be thy Adam". Assumptions of causality assume that it ought to be classicisms reality. But that was before quantum physics. I want to briefly explore the notion of causality here and how it relates to classical chaos theory and quantum chaos theory. Later, I will take a deeper look at classical chaos theory and quantum chaos theory. A very important difference in classical chaos theory and quantum chaos theory is how they dramatically affect the ideas of emergence and novelty which will be explored more later. For now, I want to look at the problem of our classical notion of causality.

The Problem of Causality

In quantum superposition all possible states of a possible effect are maintained simultaneously. Additionally, no matter how complex

classical systems are, there is a practical limit to the range of finely tuned causal structures which can be determinant of a resulting effect. The butterfly effect exemplifies the 'dream' of classical chaos theory's basis in causality. The butterfly effect assumes that ever infinitesimally, exquisite, fine initial variables can account for causality. This is analogous to a butterfly flapping its wings to produce a tornado on the other side of the world. However, the required computational complexity and degree of knowledge of the initial conditions to achieve such a determinate causal relationship is vastly prohibited by quantum physics. In spite of this, classical chaos theory maintains a belief that phenomenon is nevertheless tied to causal structures and 'one day', science and knowledge will reach a level of expertise that will prove this assumption. However, this assumption has already been proven to be false. Phase space is a primary reason why classical notions of causality are extremely problematic in quantum physics. Quantum switch experiments exhibit this acausal behavior very well.

Physicists have implemented the quantum switch in tabletop experiments. In quantum mechanics events can occur in an indefinite causal order. In other words, both "A causes B" and "B causes A" can be simultaneously true. This possibility arises from the quantum phenomenon known as superposition. In superposition, particles exist in all possible states simultaneously until they are measured. In experiments, physicists have observed indefinite causal order by using a particle of light (a photon) in a superposition of two states. They subject one branch of the superposition to process A followed by process B, and the other branch to B followed by A. The photon experiences both causal orders simultaneously. The switch experiments exploit indefinite causal order and have potential applications in quantum computing and communication. Giulia Rubino and her team at the University of Bristol led the first experimental demonstration of the quantum switch in 2017. While the practical uses are exciting, the implications run deeper.

Physicists believe that our usual picture of events unfolding as a sequence of causes and effects does not capture *phusis*. While the quantum switch experiments offer practical applications, they also highlight the need to question our understanding of causality. However, superpositions of massive objects (which affect space-time metrics) collapse too quickly for us to detect the fuzziness of causal relationships. To understand the fundamental nature of gravity, space, and time we need to radically rethink the validity of causality. The usual causal perspective does not capture the essence of quantum phenomena. The study of 'indefinite causality' is gaining momentum, especially as it relates to quantum gravity and the origins of space and time. Physicists are also exploring and utilizing the implications of indefinite causality for quantum computing and communication. Phase space challenges our classical notions of causality. As we delve deeper into the quantum world, we will need to embrace new perspectives to unlock the mysteries of gravity and the fabric of spacetime.

The quantum switch experiments also hint at a connection between quantum gravity and 'indefinite causality'. The link between quantum gravity and 'indefinite causality' is highly intriguing to physicists. However, detecting causal fuzziness resulting from superpositions of massive objects (which stretch space-time metrics) remains quite a challenge. Post-causal physics might hold the key to understanding the quantum origin of gravity, space, and time. Reversing or disrupting altogether the arrow of causality requires a very different kind of quantum theory than most people can imagine. One aspect of quantum theory is that it can just as easily reverse the thermodynamic arrow of time (since entropy increases in the direction of causal processes). Quantum gravity itself continues to remain another challenging puzzle. 499

In quantum chaos theory the Wigner function describes trajectories of stationary quantum states. 'Trajectories' can refer to many different properties of quanta. One example might be how stationary quantum states move around in spacetime. The Wigner

function works in something called ‘phase space’. The Wigner function provides information about the quantum system’s phase space distribution. The Wigner function enables classical mechanics to ‘appear’ to prove ‘absolute’ causality. However, stationary states, called eigenstates, are almost never seen in anything other than highly contrived and isolated laboratory settings and even then, statistically based due to probabilities from uncertainty. The Wigner function is a semiclassical ‘analogy’ phenomenon in the ‘wave’ function (‘wave’ is also analogical). While the Wigner function can provide an explanation of how classical causality arises semiclassically from the wave function, it also provides proof of fully chaotic systems relative to any such notion as time evolution. [500]

Phase space refers to a mathematical space where each point represents the complete state of a physical system. For example, it can combine both position and momentum coordinates for all particles in the system. Essentially, phase space captures the full dynamical information of a system, allowing us to predict its future behavior based on its initial conditions. However, quantum mechanics introduces a whole new layer of complexity. Instead of definite trajectories, particles exist in superpositions of multiple states simultaneously until measured. As discussed previously, the causal order of events has been experimentally verified to have nothing to do with the wave function’s superposition. Here is another helpful thought experiment in this regard. Imagine Alice and Bob cooking dinner. In one version, Alice drops a plate, startling Bob, who burns himself. In another version, Bob burns himself, causing Alice to drop the plate. Both scenarios can coexist in quantum reality. Here is another question which arises with regard to prediction of probable outcomes upon observation of all simultaneous possibilities – How can the wave function give us more or less likelihood of a probable outcome before experimental observation occurs?

How is it Possible that Quantum Superposition can Predict a Probable Outcome without Classical Causality?

The answer is that the calculation depends on initial conditions already set up by the experimenter. Quantum experiments are maintained in highly controlled and isolated laboratory settings. Effectively, this means a 'pre-observation' occurs before the actual observation which can *rig* the outcome so to speak in advance of the actual observation. The technical reason for this is due to the experimenters determination of the superposition coefficients. In some cases, the temporal setting is rigged in advance by the independent variable of time. The Schrödinger equation depends on unitarity which can be time, but it does not necessarily have to be time. The evolution of the wave function might be state based as in phase space, spin, charge, etc. In order to understand quantum physics, we need to give up on the idea that some kind of objective situation exists 'out there' and we are passive observers (classical science and empiricism). The probabilistic predictive capability of the quantum wave function is dependent on how we set up the experiment and when the measurement takes place. Both of these aspects of the experiment are part and parcel of the 'observer effect'. Also note that the probabilistic calculation need not be weighted on any single outcome. It is quite possible that all outcomes are equally weighted. However, even then, the spooky wave function will collapse or branch into a definite value. 501

Classical Crisis: Epistemology and Ontology? Exformation, Causality, Spatiality

As I have illustrated, quantum chaos theory is capable of explaining classical chaos theory's predictive success as a limited case, given certain assumptions, based on the Wigner function. Quantum chaos theory can explain why history drew conclusions of causality based on phenomenal observations. But history's underlying assumption

that causality extends ever more infinitesimally downward with greater and greater degrees of accuracy into initial conditions breaks down completely as we approach the quantum level. Specifically, when the ratio of Planck's constant to the action of the system approaches zero classical mechanics and chaos theory breaks down. [502] It turns out the foundation history assumed concerning absolute causality is absolutely undermined by quantum physics. To start with there are two important reasons why quantum chaos theory is extremely different from classical chaos theory.

Werner Heisenberg famously hated the wave function. He formulated "Matrix Mechanics" specifically to avoid visualizing waves. The wave function belongs to Schrödinger. The wave function and uncertainty principle tells us that the more we have knowledge about, say, a particle's position, the less we can know about the particles momentum. However, to be clear, while the measurement, "Observer Effect", describes how measurement collapses the wave function, the more we know about the particle's position the less we know about its momentum and vice versa. This "Uncertainty Principle" is an even more fundamental concept: it is a property of nature itself, where position and momentum are not simultaneously defined values, regardless of measurement clumsiness. This type of complementarity happens over and over again in quantum physics. This is not a loss of knowledge but the impossibility of knowledge. This impossibility of knowledge is not due to an inability to specify initial conditions adequately but is built into *phusis* from the ground up so to speak. Additionally, *phusis* vastly exceeds idealized pure eigenstates which are almost never found in the environment. The impossibility of certain kinds of knowledge depends on the odd observer effect at quantum scales. Plus, the spooky externality of the universal[503] wave function makes any such assumptions of classical, causal predications and predictions of phusis irrevocably break in classical chaos theory. [504] But classical causality is not just broken by the mistaken notion of

temporality, it is also broken by the mistaken notion of spatial locality.

As I stated, the idea of 'phase space' is a disruptor of causality. Entangled information in the quantum wave function defies locality. A simple way to think about classical causality is that any cause must propagate through a medium which implies locality and mechanism. Newton believed in 'action at a distance' gravity. In Newton's own words any other notion of action at a distance would be

> so great an Absurdity that I believe no Man who has in philosophical Matters a competent Faculty of thinking can ever fall into it.
>
> —Isaac Newton, Letters to Bentley, 1692/3 [505]

To add insult to injury, Einstein referring to entanglement modified Newton's 'Absurdity' to include "spook action at a distance". In classical chaos theory, infinitesimally tuned initial conditions can, to a limited degree, find an unsettled home in quantum chaos theory. Under certain conditions, the 'reduction' of the wave function can collapse or branch into classical chaos theory, but it need not. When we get to quantum chaos theory and the uncertainty of the wave function, the whole theory of causality both spatially and temporally fails to find the absoluteness of classicism. Therefore, we can give place to cause and effect in the classical world but only as a limited case of 'many-worlds', many outcomes. Chaos underlies cause and effect but also exceeds cause and effect. Chaos deprives locality, mechanism, and ever finely tuned infinitesimal conditions of any ground. Chaos deprives any certainty of existence and Being (ontological) or absolute Concept (epistemology). Chaos suspends classicism in an abyssal and spooky wave function which cannot find a permanent home in terms like objective or subjective but exceeds them without homage to binary reductions in the very odd observer effect. Entangled information,

exformation, can provide a highly contingent account of 'cause and effect' in state reduction, collapse, or branching through the observer effect. However, even the 'not' of cause as 'uncaused' fails to satisfy quantum chaos. The 'not' of bipolar dualities of either/or, caused/uncaused, resides in a kind of quantum obliviousness which can be either/or, both/and, none of the above, and radically different as the spooky observer effect.

No exformation 'exists' for entangled particles when experimental observation has not occurred. To specify a certainty in epistemology of how we know that we know or a desire in ontology of the who, the 'me' which knows as *isness* rises from historic narrative not some absolute truth of Being. To attempt to concretize an epistemology or an ontology of entangled particles which denies the possibility for classical forms of knowledge and observation would have to partake in some kind of pseudo-classical metaphysics of some type or better, what has come down to us as intuition. The problem with intuition is that history anesthetizes it with an aberration which is incapable of breaking out of a classical motif. History clothes intuition with metaphysics, a framework, an assumption of knowledge. The uncertainty or hazy middle noted in the complementarity principle prohibits any absolute conceptual, epistemological dialectic. In other words, there is no possibility of fundamentally recovering a higher order transformation driven by contradiction which, for example, could give a unified account for wave-particle duality. Both the historic narratives of higher order and lower order causal infinitesimals are spookily exceeded in quantum physics. When exformation of an entangled system is experimentally observed there is no way to epistemologically (with knowledge) secure a foundational origin prior to or in relation to the act of observation. There is no way to recover a complete classical, conceptual framework of a system as a whole in an entangled system. Even the classical assumption of 'empirical evidence' which would support a unified claim of 'reality' classically imagined has turned out to be a fool's errand. Neither can we lapse

into some kind of pure subjectivity. An observed, entangled property cannot be said to exist when it is not observed as it must remain existentially uncertain with no clear way of salvaging it in classical epistemology. What do I mean by this?

What I mean by this is there is no way to know that we know except contingently in the existential act of observation, or as Heisenberg termed it “the path comes into being only because we observe it.” This type of knowledge is not *a priori* or *a posteriori* as there is no ‘prior’ observable in superposition and no single path of informational branching. According to Schrödinger, "*not alternatives [paths] but all really happen simultaneously*."[506] Kinematics is the study of motion without regard to cause, such as the forces, which caused motion. Dynamics is the study of the causes of motion. In classical science, kinematics and dynamics are complementary. In quantum physics kinematics and dynamics are mutually exclusive. Bohr regarded this mutual exclusivity as both epistemic and ontic in an unconventional fashion due to the uncertainty principle. The uncertainty principle tells us that epistemically, in principle, properties of quanta like wave and particle cannot be measured simultaneously. These properties are epistemically incompatible meaning there is no knowledge that can explain how this works. But even more than that, Bohr’s measurement argument goes directly to the observer effect. He also tells us that these properties do not exist until they are measured.

> The mutual exclusiveness of kinematic and dynamic properties
>
> Kinematic and dynamic attributes in quantum mechanics are mutually exclusive in the sense that they cannot be simultaneously measured; they are, in this sense, epistemically incompatible. Why did Bohr think this? His reasons may seem intricate, but they are basically quite simple. Two main factors, he maintains, account for the epistemic incompatibility:

(a) measurements of these two different sorts of properties require mutually exclusive experimental arrangements, incompatible measurement procedures;

(b) the interminability of the interaction between the object and the instrument of measurement precludes extrapolation of the different measurement results to one and the same time.[507]

Later in 1938 Bohr wrote a paper entitled, “The Causality Problem in Atomic Physics.” Here is what he said,

Indeed, as adequate as the quantum postulates are in the phenomenological description of the atomic reactions, as indispensable are the basic concepts of mechanics and electrodynamics for the specification of atomic structures and for the definition of fundamental properties of the agencies with which they react. Far from being a temporary compromise in this dilemma, the recourse to essentially statistical considerations is our only conceivable means of arriving at a generalization of the customary way of description sufficiently wide to account for the features of individuality expressed by the quantum postulates and reducing to classical theory in the limiting case where all actions involved in the analysis of the phenomena are large compared with a single quantum. In the search for the formulation of such a generalization, our only guide has just been the so called correspondence argument, which gives expression for the exigency of upholding the use of classical concepts to the largest possible extent compatible with the quantum postulates.[508]

Epistemology wants to establish a reason or certainty for why we know that we know. However, with quantum physics the closest we can come to knowing certainty is knowing that we cannot know.

This negative epistemological result is counter to the history of epistemology. Even more, knowing that we cannot know is not merely a negative. There is a spooky excess to this negative which gets leveled off and reduced when thought of as merely a negative which substantiates that we can know. Quantum physics long ago settled that question as we simply cannot know with certainty. With all that stated, spookily we will never be able to prove anything about entanglement from our historic certainty of locality. Bell's theorem of inequality does succeed in epistemically proving that entanglement will never have the possibility of explanation from locality.[509] So, while the commonsense certainties of knowledge and existence have no foundation as history imagined they can arise from a hazy mist which does not simply negate them but exceeds them. Here is another case of this oddity.

We understand Bohr's problem with ontology, the question of existence posed by quanta. Not only do virtual particles pop in and out of existence but they provide zero-point energy which is the requirement for spooky wave/particle/patterns to seamlessly mutate and transition as we will see with the massless gluon particles in the "Quantum Fields" section ahead. The Higgs field does not interact with massless particles. Gluons and photons use zero-point energy to duck in and out of existence without ever seeing the universe from their perspective. Only from our relative frame can we see photons travel through the universe. From the perspective of a photon, the universe does not exist. For the photon, the universe is an infinitesimal instant. But when we look at photons, from our relative perspective we see them being curved by spacetime, curved by large mass objects, sucked into blackholes, popping in and out of existence in zero-point energy as they traverse through the universe. From our relativistic perspective as existence, photons are elementary particles. We understand them as traveling through 'time' not as entirely oblivious to spacetime geometry, the universe. The two different perspectives are completely different, logically contradictory, but live together. Yet,

we have seen this before. We nicely call this complementarity. A massless particle is a bizarre idea. It does not fit into our logic. We assume that it must be one or the other. The fact is that it is both non-existent and existent. It is abstract and concrete. In relativity it is 'relative to our reference frame'. In quantum mechanics, it is both geometry (abstract) and entanglement (spooky existence). Could it be that time is both existent and non-existent, abstract and concrete?

Exformation and Virtual Particles

Even for spooky wave/particle/patterns with mass, they are incessantly morphing utilizing schemes in quantum fields which we will get to later with electrons and positrons (anti-electrons) colliding, releasing a photon into a quark and anti-quark with the antiquark radiating a gluon. All of these transitions borrow and return spooky wave/particle/patterns from the vacuum bank of zero-point energy as virtual particles popping in and out of existence. The point here is that spooky wave/particle/patterns present a real and difficult problem for epistemology and ontology. This problem gets even more exacerbated when we think about exformation and quantum entanglement.

As we will see with Leibniz' difficulty with 'objecthood' and the Identities of Indiscernibles, quantum 'objects' present real difficulties to the history of identity. The very notion of identity is probably best understood in terms of Bohr's correspondence rule which gives a conditional amount of credence to classical sciences as a limited case of something quite different in quantum physics. Bohr spoke of classical physics as a limiting case of quantum theory. The limiting case would assume that "*all actions involved in the analysis of the phenomena are large compared with a single quantum*."[510] But as we will see later the notion we have of 'large' and 'small' is challenged by current mathematics. Additionally, throughout this book examples will be cited about our quaint

classical notions of macro-sized large *objects* and ongoing research of how quantum physics relates to these sanctities of commonsense. However, with all that stated, quantum physics does not simply set up another type of classical binary dualism as for example between classicism and quantum physics. Instead, it finds a hazy middle way which can give 'semiclassical' avenues into our classical narratives of spacetime, reality, and knowledge.

Bohr's correspondence rule can provide a limited case scenario for the metaphysics of classic physics predeterminations of 'reality' vis-à-vis "*the basic concepts of mechanics and electrodynamics for the specification of atomic structures and for the definition of fundamental properties of the agencies with which they react*" given certain assumptions.[511] Yet, after Einstein's 1935 EPR paper, this Stanford article tells us Bohr stated quite clearly: "*the whole situation in atomic physics deprives of all meaning such inherent attributes as the idealization of classical physics would ascribe to such objects.*" [512] I would add, *the whole situation in atomic physics deprives of all meaning such inherent attributes as the idealization* in history of epistemology and ontology as well.

These difficulties are amplified even more in the 'experience' or 'predictive knowledge' about an entangled property's state which would exist after the act of observation of the entangled state. In the state of superposition there is no determinative knowledge prior to observation. What we 'know' is that knowledge finds no basis in 'what is', in ontology. Neither does it validate any kind of knowledge that would satisfy a peculiar kind of epistemology based on purely contingent knowledge. More specifically, this peculiar kind of epistemological exformation would not be determinative 'fact', belief, or opinion. It would have to be a peculiar knowledge of the simultaneity of an observed entangled property without reversibility, without an underlying 'physics' which would never be able to localize it, discontinuous, without cause and effect and prior to spacetime which emerges from it in some spooky way. Even more, the 20th century and ongoing debated about the epistemology

and ontology of the quantum wave function branching off in many-worlds or "*not alternatives but all really happen simultaneously*" [513] take us down tired old paths which sound like metaphysics, but it is spookily not.

Nevertheless, there is a type of usable probability of an entangled system would make any such thing as quantum computing a 'reality'. There is a clear justification for declaring that quantum physics has been the most successful scientific theory in the history of humanity in that we can derive probabilistic amounts of predictability. To think of quantum entanglement as purely psychic would also have to rely on some kind of assumed metaphysics. Neither could it be thought of as an externality which has nothing to do with observation. Entanglement does not justify an external existence beyond the act of observation or any conception upon which the historic notions of an 'external' world has validity. This externality must necessarily include the observer and observed as an essential predicate without lapsing into some form of monadic narcissism. Neither can quantum entanglement fit into any form of fundamental skepticism or agnosticism. If quantum entanglement has an affinity with epistemology it would have to consist of some hazy middle which is not typical of any categories of historic epistemology. I do think that Levinas has a very interesting way towards a values-based ethics taken up in responsibility which has a complementary relationship to quantum entanglement but that will come later in this book. Quantum entanglement can decohere and lose its unique relationship to this oddity I am calling exformation.

Entangled particles can cease to appear as entangled from interactions with other quantum systems causing 'sudden death' or decoherence. 'Sudden death' means there is no entanglement. In this case, quanta observed as 'particles' returns to the quantum wave function's chaotic froth as the sum of all possibilities, popping in and out of existence, or be transformed into other entangled quantum systems. The nether land of quantum foam cannot be

deemed existence or simply the negation of existence. In a strict philosophical sense, the chaotic sum of all possibilities is ‘not’ (as not existent), and neither is it that ‘not’. We call this nether land virtual particles. What we know of virtual particles is required by the mathematics of the quantum wave function and accounts for essential uncertainty.

As the sum of all possibilities, perhaps as a thought experiment, we could think of virtual particles as the sum of all possible knowledge or information whether known or not. Aristotle would refer to this as potential knowledge. This potentiality has no form, no actuality, no time or space. It would be chaos in every sense of the word due to its obliviousness to assembly, cause and effect, in the universe we think of as spacetime. As mentioned, what we know of virtual particles is that they are required by the quantum wave function. The wave function was developed by strict observations to give probabilities of all known quantum behavior which may exist. A particularly important function of quantum mathematics is called superposition which means a simple summation of all possible functions which can occur under some combinations of stimuli. Some of the terms of the simple summation fall out given a particular stimulus and some describe the subsequent behavior of a particle or a system of particles. These functions employ the mathematics of complex matrices. Each function gives a more or less probable outcome of particular quantum behavior. This enables us to have an odd form of predictability we might think of as actual behavior from pure potential, mathematical conditions.

The wave function is far from complete. One glaring example would be the question of dark matter and dark energy which comprise ninety-five plus percent of the universe.[514] There are many others as well. From our thought experiment, the sum of all understanding known, and unknown is called information theory. This would be all possible cases of existence which have no actuality but are pure potential. If all possible information were

actual at every moment, this would be and is pure chaos. By 'pure chaos' I mean all information which includes exformation that would have no assumed prior cause but merely become 'real' when it is observed, when it becomes actual. Observation here implies repetition as repeated and statistically predictable behavior in specific circumstances. The hazy potential of any and all possibilities has been referred to as chaos or exformation. It is causeless. The actuality is statistical and what we call existence. In this sense, the universe is a movement to and fro of pure chaos. We see this kind of frenetic motion as heat or thermal energy which cannot be accounted for in terms of the law of conservation of energy for virtual reality because the interactions are too short-lived, and the energy is too low to measure.

We see entangled particles bubbling up from a froth of hazy existence. Virtual particles are a necessary contributor to the collapse of the wave function and what makes spontaneous randomness possible. However, virtual particles may not mean they are merely created and destroyed in our reality. Some physicists believe quantum (singular), a discrete quantity of energy, may be multidimensional meaning beyond four-dimensional spacetime.

> String theories require extra dimensions of spacetime for their mathematical consistency. In bosonic string theory, spacetime is 26-dimensional, while in superstring theory it is 10-dimensional, and in M-theory it is 11-dimensional. In order to describe real physical phenomena using string theory, one must therefore imagine scenarios in which these extra dimensions would not be observed in experiments.[515]

This could and has contributed to theories of parallel universes, the ancient Greek notion of many-worlds, and string theory.

> The multiverse—the idea that there are an infinite number of other universes out there besides our own—strikes many as

not only odd, but also exceptionally modern, arising from contemporary physics. But in fact, the notion that there are many worlds besides ours is ancient, stretching back at least 2,500 years. Although the multiverse is never postulated as such in the writings of early thinkers, it's an implication of efforts to solve some other problem, be it metaphysical, theological or scientific.

The earliest hints of the multiverse are found in two ancient Greek schools of thought, the Atomists and the Stoics. The Atomists, whose philosophy dates to the fifth century B.C., argued that that the order and beauty of our world was the accidental product of atoms colliding in an infinite void. The atomic collisions also give rise to an endless number of other, parallel worlds less perfect than our own.

Unlike the Atomists, who described reality without recourse to a divine being, the Stoics saw the cosmos to be imbued with an eternal, indestructible soul. But how to explain the apparent change and destruction we see? The universe recycles itself anew. According to third-century B.C. stoic philosopher Chrysippus of Soli, the world would eventually deteriorate into a sort of ethereal nothingness, but then regenerate again into material form, only for the cycle to repeat itself ad infinitum.

The Atomists held that atomic collisions give rise to an endless number of parallel worlds less perfect than our own.

Although there are sharp differences between these two Greek philosophies, their respective ideas of cyclic and parallel universes are not necessarily mutually exclusive. In another part of the ancient world, around 100 A.D., early Buddhist philosophers sought to describe a cosmology of causation, but without invoking a first cause. Their solution? Our world is one of many parallel worlds, each of which undergoes its own infinite cycle of creation and

destruction.[516]

Quanta (plural) may be multidimensional strings which we only catch glimpses of. An ontological narrative of entanglement may be understood as indicators of multi-verses or parallel universes. In that narrative there would be no known reason why the multi-verse could not be infinite. I find that narrative more useful as a visual analogy, but the literal interpretative analogy seems to get stretched too far in the direction of classical ontology. In our thought experiment along classical lines chaotic energy as heat is the sum and limit of all potential spacetime information might be thought of as randomness in spacetime. However, in the quantum wave function this would be chaotic information inclusive of exformation. The change in entropy in spacetime is related to heat capacity. Quantum entropy is a measure of the amount of entanglement information, exformation, and comes out of quantum information theory. The question of exformation revolves around the question, "What is locally real?"

One of the more unsettling discoveries in the past half a century is that the universe is not locally real. In this context, "real" means that objects have definite properties independent of observation—an apple can be red even when no one is looking. "Local" means that objects can be influenced only by their surroundings and that any influence cannot travel faster than light. Elegant experiments with entangled light have laid bare a profound mystery at the heart of reality. The evidence shows that objects are not influenced solely by their surroundings, and they may also lack definite properties prior to measurement. Investigations at the frontiers of quantum physics have found that these things cannot both be true. The property of the position of a particle is clearly non-local. It is represented by an operator which has all possible positions of the particle as possible eigenvalues. Any operator which does not commute with it will make the particle's position be spread all over the place– i.e., the particle does not really have a locality. The

Nobel Prize in Physics 2022 was awarded to John Clauser, Alain Aspect, and Anton Zeilinger for their experiments with entangled photons, establishing the violation of Bell inequalities and pioneering quantum information science. Bell inequalities put the final nail into the coffin of classicism. 517

Could it Be?

Philosophical phenomenology which started around the time of Einstein wanted to get away from abstractions like linear distance and abstract 'now' moments as constituent of temporality. Phenomenology preferred the term lived space to the abstraction of feet and inches, linear extension. It seems to me that the physics of entanglement provides a cogent reason why we have a sense of lived space which can be incongruent with abstract space as linear extension. So, even though entanglement acts as if time and space does not exist, entangled systems gain a sense of proximity by the amount of entanglement particles or density of entangled particles in a system, like our body. The density of entangled particles engenders a feeling of closeness. Entangled particles in our body are denser and give us a feeling of 'closer'. However, the entangled particles in our body entangle with other entangled systems. Even more, observation and attention have a role to play in how we entangle with other systems as we have discovered. If I am wearing glasses and focusing on a cup of coffee, I feel closer to the space of the coffee cup than the glasses on my face. Through attention, I am acquiring more entangled particles with the coffee cup than the glasses on my face, so my lived space feels closer to the coffee cup than the glasses on my face. If I am in love with someone, even if they are miles away, I feel closer to them regardless of the distance. I might add that also works in a negative direction. If I hate someone, it does not matter how far away they are. I feel disdain and anger even if they are nowhere around. The wisdom traditions tell us that hate hurts the one that hates by transforming the hater

into the hated one. Another word for this is Karma. Additionally, the lack of attention gives us a sense of distance. When we are oblivious to a tree or stars at night, we feel 'further' away from them. When we wonder at them, we bring them closer to our living space. Heidegger talked about anxiety as a feeling when everything withdraws from you. In anxiety we feel far away from everything, not connected to anything. This feeling of alienation could be a lack of entangled systems with anything other than ourselves, where everything else gets coopted into the value systems of the self. When anxiety is internalized over a period of time, we become numb, desensitized. In this detached state we only hear our own echoes of ourselves. We and others become objects of petty gamesmanship where only exchange measures the volume of our echoes to ourselves. As historic beings perhaps we acquire a sense of closeness to a particular narrative of history, language, and culture, perhaps a branch of the quantum wave function which must be digested as 'real'. We define ourselves and meaning from entanglement with a historic narrative. However, to the degree that our 'real' becomes absolute is to the same degree that the other gets subducted into our narrative. The state reduction of the other to my absolute narrative of the other is the banishment of the radical alterity of the other into the underworld of the self, where only the voice of echo can be heard. The main point here is that our lived sense of closeness and far away may be the very phenomenon of entangled systems.

So, now we have a sense of spacetime formed not by classical Euclidean geometry like an x and y axis but by more or less densely entangled particles. This is unimaginably dynamic in the quantum wave function. Einstein's relativity is based on spacetime at the largest scales. It does not tell us a lot about spacetime on the smallest scale. Yet, relativity tells us about the warping of spacetime even at the most severe scales as in singularities. Warping of spacetime produces gravity. However, when we look at the smallest scales it seems that Einstein's spacetime falls apart. Spacetime

becomes chunky and entangled without space and without time except on an observational basis. Again, by ‘observational’ I am not referring to a subjective self in an objective Frankensteinian mechanism of matter.

However, if we shift our idea of spacetime to the idea of the density of quantum entangled systems, according to Steve Strogatz,[518] we can see a kind of Einstein's spacetime of relativity emerging in a very spooky fashion. If we take an entangled system in its lowest energy state and perturb it a little with a small amount of energy, we will see the number of entangled particles or better, density of entangled particles, in the system change. As the number of entangled particles changes so does near and far. Effectively, we are changing spacetime or better lived-spacetime…and I would add ‘observationally’ in the odd sense of state reduction of the quantum wave function. Could it be that this stretchiness of spacetime is how we actually live spacetime as 20th century phenomenology tells us?

Additionally, the geometric change of spacetime produces what we think of as gravity with highly massive systems like our planet and perhaps we may also find at Planck scales of entanglement as well. So, by changing the entanglement of a system we are changing the geometry of spacetime which, on a large enough scale, produces gravity. This then would be called quantum gravity. This establishes a relationship between the quantum world and relativity vis-a-vis geometry not some pre-ordained notion of absolute time and space. Quantum field theory is not just the wave function which predicts probabilities about how quantum particles behave when perturbed, it is how these particles behave in fields. Fields are like magnetic fields. However, electromagnetic fields are produced by any particle which has charge, i.e., as positive or negative charge. Electrons have a negative charge. Protons have a positive charge. When quantum fields change geometry, we have established a relationship to spacetime. Therefore, quantum field theory, to be discussed later, is ideal for investigating how quantum mechanics and gravity might work together. In the future or in science fiction today, perhaps we

could create tiny universes in a laboratory.

Haunting Entanglement

From now on, throughout this book when I refer to spooky or spookily, I am using this as a shorthand to refer to the necessary observational component of the quantum wave function, its superposition, its odd collapse, or better branching informational updates which cannot be thought of in classical terms of history and languages which develop from the odd dynamic narrative of state reduction. We have no easy, accessible way to think of the wave function and its collapse as *phusis* so I will use Einstein's highly appropriate word – spooky which is implicit in my term 'odd' for how we experience quantum wave function state reduction.

Interesting enough, in Plato's Republic he recounts the ancient Greek myth of Er. However, instead of using the Greek word myth, Plato uses the Greek word *logos* which is discussed later in this book but for now I will simply define it as word, speech, or account. The tale is about what happens after death. In earlier Greek mythology *Lethe* is one of the five rivers of the underworld. *Lethe* means oblivion, forgetfulness, or concealment. The other four rivers in the underworld were *Acheron* meaning river of sorrow, *Cocytus* meaning river of lamentation, *Phlegethon* meaning river of fire, and *Styx* was the river that separated the earth from the underworld. In Plato's version Socrates explains to Glaucon, Plato's older brother, that after Er died, the gods showed Er that every soul is required to choose their next life. Many choose badly for fame, glory, riches, and pride. After they choose, they have to drink from the grail of forgetfulness (*Lethe*) upon which they are reborn into whatever life they choose. Those who choose foolishly found out too late that they had to suffer horrible consequences like eating their own children. However, the gods required Er to return to the land of mortals to report what he had learned concerning what happens after death. According to Greek *logos*, this is how we became aware

of what happens after death.[519] I find all this a bit intriguing since I can see how, in Everett's idea, this could fit in with information updates (as the karmic path we choose…observe in an odd sense) which irretrievably branches off from the quantum wave function (the grail of forgetfulness as superposition and information branching).

Quantum physics has known from the earliest part of the 20th century to the present that spookiness is with us to stay. We are not going to change quantum physics. We need to let quantum physics change us. But first we need to apply ourselves to what it has been telling us and how it marks the end of an epoch. Classic physics finds itself relentlessly mired in the bog of infinites which becomes an absolute narrative guiding all possible further inquiry. More literally, ever infinitesimal initial conditions like the butterfly effect which gets taken up into the sublime metaphysics of absolute cause and effect, modernistic mechanism. Metaphysics is an endless historic narrative which goes on and on branching off forever into the sublime.

But when quantum physics ushers in artificial intelligence housed in the body of a quantum computer, the sublime, *phusis*, will be looking back at us. The approaching void looking back at us has already started engendering reactionary movements worldwide in which folks are skirmishing back towards ready-made, mostly imagined, and aging historic narratives. These historic narratives are dying not because of liberals and Marxists but because of the impending end of modernism and all that it desperately defends. 'Reality' has been hollowed out from the inside for many reasons. Justice, democracy, ethical values have led us to the brink in concert with quantum physics and artificial intelligence have pulled the ground out from under us. The way backward means denying all the 'realities' we thought we so dearly loved. We must go forward…but to what?

Quantum entanglement is not some questionable theory of physics.

> Three quantum physicists have won the 2022 Nobel Prize in Physics for their experiments with entangled photons, in which particles of light become inextricably linked. Such experiments have laid the foundations for an abundance of quantum technologies, including quantum computers and communications.
>
> Alain Aspect, John Clauser and Anton Zeilinger will each share one-third of the 10-million-Swedish-kronor (US $915,000) prize.[520]

So, what was so haunting about quantum entanglement?[521]

In the 20th century the classical notion of machines came to be a limited case of something vastly more sophisticated and much more relevant to what shows itself in modernist Frankensteinian phenomena. Now, we know that the idea of 'particles' is more useful to explain one aspect of the 'wavicle'. However, it can also be misleading as particles are not solid at all. Rather, they are also actually fields of forces which have particular properties and obey forces such as weak and strong atomic forces and electromagnetism and gravity if gravitons exist. Atoms are made up of much smaller subatomic particles or forces. These subatomic particles are the domain of quantum mechanics. Currently, quantum mechanics eloquently describes weak and strong forces and electromagnetic particles. It is just beginning to reveal avenues into the origin of the fourth force, gravity. And as we have seen even that origin falls into irrelevance in the quantum wave function.

Quantum entanglement shows us that the smallest particles have a bond which defy, are oblivious to, spacetime and can be shown to give rise to spacetime.[522] Particles are not little specs of solid 'matter' like dust or sand. This notion is yet again another way in which philosophy, built into language, has predetermined how phenomena is allowed to show itself through common perceptions. Classic physics, religion, and underlying philosophies made 'common-sense' inevitabilities of what shows itself in phenomena to

essentially be matter, stuff, hard bodied things like gears in a machine. Early on in that paradigm, mind and spirit presented a messy difficulty for this mechanistic reasoning. However, later in history this reasoning was overcome in modernism and the analytic traditions of philosophy of science and even continental (European/Roman/Greek philosophy). Mind and spirit were simply equated to such notions as 'evolutionary machines' where evolution itself was understood as a complex biological machine.[523] Starting in the 19th century, these notions in academic science and philosophy became increasingly under scrutiny. Let's take a look in physics to see how entangled properties go against predeterminations of mechanism.

There are many properties which can be observed in two entangled particles like position, momentum, spin, etc. which, when measured or observed, behave as if they are the same particle. Additionally, systems of entangled particles comprise everything we see as 'reality' including ourselves. These systems dynamically migrate. They are in perpetual decoherence with regard to their entanglement and re-entanglement transitioning from one system to another. With current quantum physics, as physically entangled systems become smaller, the probability of accurate predictive behavior in their migration is significantly better when compared to predictive behavior given by classical physics. Let's focus on the simultaneity of entanglement.

I will use the specific property of spin as an example of an entangled pair of particles. Note that this is only an analogy for visualization. Quantum physics' notion of spin does not involve rotation. This will be discussed in more detail later. Think of the toy we call a 'top' spinning. Now think of the toy we call a 'top' as composed of water. We shall call this a water-top. The water-top is in an ocean with all kinds of fluid dynamics going on all around it. Certainly, tops can spin straight up along a vertical axis or diagonally. Our water-top could spin 360 degrees along this axis. But actually, in quanta we find that the directions are quantized to specific values of angular momentum. We could also talk about how

fast our water-top is spinning, which is kind of like what physicists would refer to as momentum. However, for now let's consider the simple example of the vertical axis. Let's call this top spin. If we turn the top upside down, we will call this bottom spin.

Now, let's think of two water-tops spinning on opposite sides of the ocean which are entangled. If one water-top is observed [measured] to have top spin, the other water-top will necessarily be observed to have bottom spin and vice versa. Further, the first observer is male, and the second observer is female for clarity. One caveat here is that these observations are statistically correlated. This means the more observations, the higher the correlation and the more certainty that the particles are still entangled. For now, just accept that physics has proved over the course of the 20th century that the states of both water-tops before we look at them are all possible states and mixtures of them. This is called superposition.

> The superposition principle is also associated with the dualism between determinism and quantum randomness: The shape and location of the envelope of the interference pattern are strictly determined by a wave equation. The square of the wave amplitude represents the probability to detect a single event. Each individual realization is, however, objectively random within the predetermined probabilities.[524]

So, if we design the experiment such that only top spin and bottom spin are allowed when an observation is made there is a 50 percent chance that the first water-top will have topspin and the second water-top will have bottom spin OR the first water-top will have bottom spin and the second water-top will have topspin.

Our two water-tops are on opposite sides of the ocean. The male observes the spin of the first water-top at an angle of 45 degrees and discovers the first water-top has top spin. Now, if the female

observer looks at her water-top at the same angle of 45 degrees, she will always observe the correlation that the second water-top has bottom spin. We can call this observation quantum wave collapse or information update with the caveats already discussed. The instantaneous moment he sees top spin on the first water-top we have statistical certainty (because of the Heisenberg Uncertainty Principle) that she sees the second water-top to have bottom spin. This observation happens as if there was no ocean in between the water-tops. It occurs instantly and statistically identical, meaning *as if* they were one water-top not two. In other words, there is no spacetime or ocean in between them - none. Additionally, as long as she observes the second top at a 45-degree angle, she will see that same result.

Let's replay the observations above with the exception that she does not look at the water-top from a 45-degree angle. Let's say she looks at the second water-top from a 65-degree angle. As far as entanglement is concerned the new angle means the water-top is still in a superposition state until she observes the water-top. Thus, before her observation, she will have a 50 percent chance of seeing the water-top's spin up or down. If she now looks to see that the second water-top has top spin (information is updated), when the first observer looks again at a 65-degree angle he will see his water-top has bottom spin.[525]

Entanglement is not done by one particle doing something and then the other particle reacting to it. When spin measurements of entangled particles are measured along varying axes, prior to observation, both entangled particles are informationally as if no observation was ever made. When we change the axis of observation of two entangled particles', their spins are in the state of superposition. It would be tempting to call this a reset. However, 'reset' assumes time, cause and effect. In the case of the quantum wave function, superposition is not a reset since it is not subject to time. It is as if no prior observation had never happened so in our case of observing two entangled particles' up or down spin, we have

a 50/50 chance of having any particular correlation without any retention or history of information from the previous observation. Entanglement is a very difficult notion to think about because we have no historically accessible ways to think about it. We prefer to think of entanglement according to the history of physics, which evolved after the history of *phusis*. But an important question to remember, **was information updated historically? No** … remember the cat in the box and many-worlds interpretation (what philosophers call hermeneutics) …

Cause and effect are a meaningless concept for the informational relationship between entangled particles. Before entangled particles are measured for a specific property (i.e., spin), their states are all possibilities. Upon measurement, the idea of what measurement came first is inconsistent. This means, the correlation between the two measurements cannot be explained as one measurement determining the other: different observers would disagree about the role of cause and effect rendering cause and effect itself meaningless with regard to exformation.

Two entangled particles separated by space would seem to also be separated by time since Einstein showed us that space and time are the same 'thing'. However, the relativity of spacetime is not conserved by entanglement. What I mean by 'spacetime not being conserved' is that with regard to the informational content between two entangled particles, spacetime has no meaningful reference or relationship to spacetime. There is no informational medium which could be thought of as a spatial byway and/or temporal sequence between entangled particles. No matter what varying continuous frames of space time we want to conjure up, the informational exchange of two entangled particles has no hint or correlation to relative spatial temporal frames and the limiting effect of the speed of light.

Einstein's relativity has no way to explain the informational content between two entangled particles. If there were such a way, Einstein would have found a local explanation to solve the

‘spookiness’ of entanglement. Locality, cause, and effect, gets irretrievably jumbled up so that there is no temporal-spatial way to employ cause and effect to explain the informational relationship between two entangled particles. And, according to Bell’s inequalities and more convincing results after that, there never will be. Even some quantum physicists are not built to explicitly state that there will never be a way to return to cause and effect and the temporal-spatial continuity involved in exformation. While they have made this critique of our common notions of ‘reality’ as certain as physics can be, they are rightly guided by avoiding any hint of dogmatism and opinion. Historically, the 20th century has proven over and over again that even physicists articulating this idea can be clumsy and awkward in notable cases.[526]

General relativity understands spacetime as smooth and continuous. Quantum physics is chunky and discontinuous. Inertial frames of reference are in a purely abstract sense, independent of acceleration (actually all relative frames are accelerating relative to each other). In the case of entanglement, general relativity should be able to decide relative states between two entangled particle’s sharing of information. If I am in an accelerating inertial frame with one entangled particle and you are in another frame which is accelerating differently with my entangled particle, we should be able to solve the relativistic equations that predict the temporal-spatial conditions of our entangled particle’s information flow. From my frame I should be able to observe the spin of an entangled particle and you would be able to see the correlated, but temporally/spatially variant, spin of the particle in your frame and we should be able to relativistically understand how our particles interacted based on the speed of light. But with entanglement both myself and you could claim to be the initial cause of the observed spin and we would both be right and both wrong. This has led to the idea that the effect happened before the cause.[527]

In perhaps less (or perhaps more) mystic terms, time and space seem to have nothing to do with entangled spin behavior or any

other of the many properties of entangled particles. Entanglement does not even recognize the speed of light. Some have said it is faster than the speed of light but that is yet another way of trying to think of entanglement as the result of cause and effect. When we do this, we again lapse into desperately trying to think in terms of history and 'common sense'. It is better to think about entangled particles as entirely separate from cause and effect, and gravitational geometry of spacetime as emergent from entangled quanta.

A Brief Interlude

To be clear, we are not thinking like "well it is one or the other even if I have not looked at it yet". Neither are we thinking a day will come along when we know more or have more advanced technology to observe our water-tops or entangled particles to prove that they are definitely and certainly spinning in one fashion or the other even when we are not observing them. Nay! Not an option folks. Physics has proven in many ingenious and sophisticated experiments that the state of the water-tops is not just mathematical uncertainty - it ***is*** the uncertainty of all possibilities occurring at once in 'reality'.

Let's notice the awkwardness in juxtaposing what quantum physics is telling us and what the language I used in the last sentence is telling us. Since Aristotle, the principle of noncontradiction has reigned supreme as logic (*logos*). With Aristotle *logos* lost its ambivalence from earlier Greek ideas which tolerated chaos and indeterminacy as *logos*. Early Greek notions of *logos* had more to do with the capacity of language to show ambivalence which the ancient Greek mind faced. Earlier *logos* tolerated and even celebrated order and disorder, form, and indeterminacy. Earlier *logos* had not yet been crystalized into logic. Quantum physics hearkens back to that ancient voice. With Aristotle, the later idea of *logos* discredited the earlier notions based

on the principle of non-contradiction. This became the dominant idea in Western history which became the basis of identity and thus, logic.

> From an early time Heraclitus was seen as the representative of universal flux in contrast to Parmenides, the representative of universal stasis. Cratylus brought Heraclitus' philosophy to Athens, where Plato heard it. Plato seems to have used Heraclitus' theory (as interpreted by Cratylus) as a model for the sensible world, as he used Parmenides' theory for the intelligible world. As mentioned, both Plato and Aristotle viewed Heraclitus as violating the law of non-contradiction and propounding an incoherent theory of knowledge based on a radical flux.[528]

At the advent of 20th century physics, we see an extreme departure from the history of rationalism which does not topple over into the logical opposite of irrationalism, the embracing of contradiction, but another path altogether which situates logic and the principle of non-contradiction into a history – classicism. Physics begins to understand that classicism is a limiting case not an absolute logic.

> One of the intriguing aspects of physics is related to the fact that quantum states are well-defined even when they refer to situations, which we would describe as a "coexistence of mutually excluding possibilities" in classical physics. We usually adhere to Aristotle's sentence of noncontradiction that "the same attribute cannot at the same time belong and not belong to the same subject." Quantum physics teaches us that we either have to give up this wisdom or otherwise renounce on other well-established intellectual concepts, such as our understanding of reality, information, or space-time.[529]

In this way physics resonates with an earlier, intuitive notion of *logos* which was articulated by Heraclitus and other earlier Greek philosophers. But physics also departs from the idealism in which 'all predicates reside within the subject' as articulated by Leibniz and eventually Hegel. The hazy middle does not rely on the mutual oppositions of subject and object, same and other, but on a kind of nether land in which subject - observation, and object - uncertain predication, are in some spooky way taken up as informational updating. Updating is not exclusive but inclusive of all possibilities. No underlying Concept emerges which accounts for, explains, makes immanent, a decisive outcome.

The failure of Western history is becoming most apparent in the inability to be able. Increasingly the historic sufficiency of Being, of ontology, is becoming meaningless. The strategy of Being is to hide and simultaneously assert itself in its mostly forgotten and assumed repetition of its 'verbing', the verb to-be, the is', are's, am's, etc. This verbing founds and insidiously, continuously authorizes the 'real'. Reality is the stamp of authenticity for an entire history which can only re-assert itself as a barely visible reverberation, cloaked in the smallest of words, doubling down repeatedly in all our linguistic determinations of the verb to-be. It is this certainty, this subliminal vehicle which cannot allow a hazy middle and excess between presence and absence. This is the violence of force which, as we will see later for Levinas, perpetuates war.

How We Know that We Don't Know

Our inherited notion of reality does not exist. The conundrum of quantum physics is that what we think is 'real' does not exist apart from us as objective, as something which just '*is*' whether we know it or not. We have no easy words or ways to think about what *is* in the context of quantum physics. Without trying to sound like a mystic, even thinking 'what is' already makes us think we know something we really do not know. We easily slip into ready-made

answers because history has not provided us with easy answers about quantum physics. In quantum physics history has finally and ultimately failed, reached its limit, its termination but without culmination or fulfillment as *telos* – with a whimper. History will never come to our rescue and usher us into the promised land of certainty which is relevant or even irrelevant to us. Moreover, as long as we are passive and disinterested, we will never know what we do not know. To begin to know what we do not know we will have to actively wrestle with the avant-garde of physics and philosophy.

> Local realism is a quick way of saying two principles: 1) Principle of locality: the cause of a physical change must be local. That is, a thing is changed only if it is touched, and 2) Principle of realism: Properties of objects are real and exist in our physical universe independent of our minds.[530]

Bell's Theorem was a strong early reason why physicists gave up on trying to think of spacetime as local and that our idea of 'real' is not real at all. The machine is an easy historic notion which is a metaphor for local realism. An early and convincing reason we know that 'reality' is not a machine-like cause and effect phenomena is from Bell's Theorem. Bell devised a family of results which must be satisfied to account for locality. Locality means physical proximity. Parts of a machine are sequentially and proximally placed so that they can interact producing a work result. Bell's theorem gave us objective ways to test for proximity. If some phenomenon violates these theorems, we must give up the notion that the phenomenon can be explained locally.

> Bell's Theorem is the collective name for a family of results, all of which involve the derivation, from a condition on probability distributions inspired by considerations of local causality, together with auxiliary assumptions usually

> thought of as mild side-assumptions, of probabilistic predictions about the results of spatially separated experiments that conflict, for appropriate choices of quantum states and experiments, with quantum mechanical predictions. These probabilistic predictions take the form of inequalities that must be satisfied by correlations derived from any theory satisfying the conditions of the proof, but which are violated, under certain circumstances, by correlations calculated from quantum mechanics. Inequalities of this type are known as Bell inequalities, or sometimes, Bell-type inequalities. Bell's theorem shows that no theory that satisfies the conditions imposed can reproduce the probabilistic predictions of quantum mechanics under all circumstances.[531]

In other words, any possible theory of locality which passes this test of Bell's theorem cannot reproduce "*the characteristic trait of quantum mechanics*" in the entangled exformation of quantum physics. Any experimental conditions which pass this test cannot be considered non-local and therefore, cannot be considered entangled. Quantum physics cannot be local. Quantum physics cannot be thought of in terms of classical physics, or even general relativity's continuity of time and space. To be fair, there are some very recent ideas of quantum physics which try to use semi-classical ideas to pass Bell's inequality non-locality test by not satisfying its conditions. One idea is to reject unique outcomes which appear to jettison locality altogether. The other idea is to reject the measurement independence assumption which appears to reject the idea of time as proceeding from a present to the past. This is called 'super-determinism'. It seems to disallow cause and effect so the experimenter's observation causes Bell's inequality test to fail obscuring an underlying locality which otherwise would have passed. Somehow, phenomenon 'knows' that you are testing it with Bell's theorem and plays a magic trick on you. This exemplifies the

extremes to which folks will go to try to get around the spooky notion of entanglement. Later, I will get more into other ideas similar but less obvious than this one to understand spookiness. In any case, neither one of these ideas would sit well in classical physics.[532] The main point here is that failing Bell's inequality test is the high bar in physics which proves or disproves non-locality or entanglement.

The No Exit of Thinking

Even as far back as our Latin inheritance, the Latin word, *natura* (noun - nature) quietly took the place of the ancient Greek word *phusis*. *Natura* is from Latin meaning "course of things; natural character, constitution, quality; the universe," literally "birth," from *natus* "born," past participle of *nasci* "to be born," from PIE (Proto-Indo-European) root *gene- "give birth, beget. *Naturalis* is the adjective form of *natura*. It is also interesting that the word "origin" comes from the Latin word *originem* meaning a rise, commencement, beginning, source; descent, lineage, birth," from stem of *oriri* "arise, rise, get up; appear above the horizon, become visible; be born, be descended, receive life;" figuratively "come forth, take origin, proceed, start.[533] Note that both of these words from the beginning also have to do with birth and terms of privilege like character, constitution, quality, lineage, birth, become visible, and receive life. [ii] I will come back to these contextual similarities later in this book.

Jacques Derrida in the 20th century would refer to these histories of ideas as the 'proper' and as 'signature' or 'signet' which authorizes the proper. Derrida shortened naming this history in his made-up word "logocentrism". Every historic repetition of the proper amplifies its relevance and simultaneously submerges its visibility in conscious awareness. In our current topic, we have no proper way to access the '*thinking of entanglement*' from our linguistic inheritance of *naturalis* (nature). Even in my previous

sentence, writing the '*thinking of entanglement',* we would more properly phrase this as 'what entanglement ***is***' which exemplifies repetition authorizing classic narrative themes of ontology and epistemology.

This simple linguistic difficulty already pronounces, and insidiously hides, Derrida's notion of the proper as 'nature'. The point here *is* that we need to recognize that thinking, history, and language does not even give us the commonsense tools to begin to fashion an understanding of entanglement. At times I draw connections with 20th century physics and philosophy and common-sense culture. While I am not a sociologist, I do believe at the present moment in history we are, as humans, facing challenges all over the world which have fundamental differences quite different than that of previous challenges to social fabric. Climate change, relativity, quantum entanglement all strikes at the heart of classic metaphysics. While most folks are not aware of these difficulties, absolutes that undergirded cultures for centuries are collapsing. We see this in declines in religious participation, more fanatical religious and political groups, ethnic and social norms assumed by these fanatics as transgressions of past norms (narrated and absolutized/sanitized, etc.) All this in concert with technology's social unraveling through networking, the breakdown of locality in social networking (small clusters of gossip, conspiracies, etc.), *democracy* sold to the consuming public as the power of the individual, of individual rights, 'my' rights over and against the other, which insidiously eats away at democracy - the democratic majority of voters giving way to fanatical minorities, diminishing protections of environment, equality issues concerning minorities, ethnic, gender issues, religious persuasions, etc. All of this requires ethics when the 'absolute' individual does not get their way in a democracy. But I digress, more on this later.

We have seen how entanglement is not physical in the way we *naturally* want to think about it. Rather, entanglement is informational. Entanglement is the basis for quantum computing.

We will explore these notions later as well. For now, let's return to how our history and language present a difficulty to the very *thinking of entanglement*. Let's examine the difference in how classic science and quantum physics understand the idea of probability. Classical science developed much of the mathematics of probabilities. However, classical science took for granted that underneath probabilities actual processes were occurring locally in absolute space and time. The philosophical school of positivists assumed that eventually beliefs would be replaced with real, actual processes which would eventually be determined fully as science progressed from empiricism. Classical science thought of 'reality' as fundamentally machine-like and merely a result of cause and effect as it very gradually separated itself from its own history of alchemy. However, quantum physics has proven that this underlying assumption of 'reality' was false. There is no cogent narrative of reality which lies underneath entanglement that one day will be validated when we have the right theory or better measurement technology. Many ways to explain entanglement as some enduring phenomenon which can be derived from all our familiar categories of cause and effect, spacetime, subject and object, ontology (the study of Being) or epistemology (the study of how we know what we know and not mere opinion), Being or Concept all fail in this witchy, spooky, caldron of entangled toads and poison hemlock and yew.

The Failure of Intuition and Phusis

As I mentioned earlier it seems philosophy and physics are finding some interesting common ground now especially with regard to quantum physics. I have also brought out some ancient intuitive ideas which are again finding commonality with quantum physics. However, the ancient intuitions of some of the earlier Greek philosophers were beset with struggles brought on by ancient wars and massive suffering. My goal is not to reify these ancient

philosophers as originators of ideas somehow congruent with quantum physics or the philosophy of Levinas. I bring up these ancient intuitions to show a different strain from the dominant ones we received in subsequent histories.

Seriously, epistemology has been concerned with how we can distinguish opinion from fact. Classically, this has made a kind of alter-ego of opinion to fact in which subjectivity is merely subjective and fact is objective. This dichotomy is a reduction. It should already inform us how certain classical ideas in epistemology have overlooked the uncertain and spooky concerns from the quantum wave function which necessarily must always branch with the observer effect. At least minimally this demonstrates that absolute distinctions between subjectivity and objectivity have some kind of hazy middle which can neither be one or the other. Additionally, at least positivists have been firmly rooted with modernists regarding their emphasis on the senses as the source of empirical observation. I would note that this is not true of subsequent anti-positivists which are not so tied to sense data as their predecessors were. Observation in terms of the quantum wave function clearly shows an underlying problem with modernist epistemologies based in classical, modernist senses. Modernism in its emphasis on the senses minimizes intuition reductively as subjective experience and even logic in favor of sensory observation. But intuition certainly has value regarding providing a certain kind of historic narrative which may have later turned out to underly scientific and philosophical paradigms. Intuition can be thought of as insight that arises spontaneously without rigorous analytic, conscious reasoning. It operates through what psychologist Daniel Kahneman calls “system 1”, which is fast and intuitive. While this intuitive system has its place—such as anticipating threats or recognizing opportunities— certainly it is also prone to a certain probability of error. For instance, the framing effect can lead to biased decisions based on how a problem is posed. Critical thinking and analysis, associated with the slower

“system 2”, are less susceptible to producing bad decisions. Scientists often engage this slower system to avoid pitfalls. But scientists do not rely solely on textbooks and papers. They draw upon their intuition and experience when answering scientific questions. Imagining possibilities and then exploring them is essential for scientific inquiry. Uncertainty in science makes intuition and judgment valuable tools. While science is based on coherent reasoning, it also acknowledges that intuition plays a role. Listening to gut feelings occasionally contributes to successful research. Additionally, even the most rigorous empirically demonstrated classical science has tended to find later historic corrections and errors. It appears that in view of the observer effect in quantum physics, probability and subjectivity, inseparable from observation, provide branching narratives which do not fit cleanly in classical epistemological structures. Even recent historic evolutions in analytic philosophy have emphasized language and narrative. 534

The linguistic turn characterizes a change in the development of analytic philosophy. It gained momentum through the works of philosophers like Ludwig Wittgenstein and the Vienna Circle. This turn led to increased attention to logic, philosophy of language, and the distinction between ordinary language philosophy and ideal language philosophy. Rather than treating philosophy as empirical science or supra-empirical inquiry, the linguistic turn views it as an a priori conceptual discipline. Its goal is to elucidate complex interrelationships among philosophically relevant concepts embedded in established linguistic usage. By doing so, it aims to dispel conceptual confusions and address philosophical problems. The linguistic turn has significantly influenced the trajectory of analytic philosophy, emphasizing language’s pivotal role in philosophical inquiry. 535

Yet, it might in some cases, as we have seen from the ancient Greeks, gleam truths which must necessarily remain uncertain as language, the habitat of commonsense, does not easily have the

ability to be able to find the words, the *logos*, to accommodate these intuitions. It seems that epistemology insofar as it aspires to the certainty of truth will never find its absolutes. The odd thing about entanglement is that even in utilizing the historic tools of the scientific method where positivistic and empirical certainty has ruled, we have arrived at a place where epistemology and ontology, facts true by definition or *'a posterior'* facts derived by reason and logic from sensory experience themselves, have become problematic. How is it that classic epistemology turns upon itself, becomes unsettled, finds unease, makes awkward our underlying assumptions of reality in the explicit case of quantum physics' spooky uncertainties and yet not lapse away into skepticism or cynicism?

Parmenides (515 [Diogenes Laertius] or 540 [Plato] – mid 5th century BC), a contemporary of Heraclitus (540-480 BC), has been typically contrasted to Parmenides as the philosopher of the contradictory, erratic, and random. Parmenides writes fluidly and poetically in Homeric hexameters.

> For Parmenides, the mark of what is known is that it is something that genuinely is, with no taint of what-is-not. That is why, for him, what-is not only is, but must be and cannot not-be. He sets this out in the key passages of DKB2 and B3/LM19D6:
>
> Come now, and I will tell you, and you, hearing, preserve the story,
>
> the only routes of inquiry there are for thinking;
>
> the one that it is and that it cannot not be
>
> is the path of Persuasion (for it attends upon truth)
>
> the other, that it is not and that it is right that it not be,
>
> this I point out to you is a path wholly inscrutable
>
> for you could not know what is not (for it is not to be accomplished)
>
> nor could you point it out… For the same thing is for

thinking and for being. [536]

Parmenides is the author of harmony and beauty. Parmenides tells us that to not-be is nonsense, non-being is nothing, it is a contradiction. To think the thought '*is not*' is an infinite regression. '*Is not'* contradicts itself immediately in two words. We cannot assert '*is'* and then make any sense of the '*not'* which follows. The 'not' is wholly inscrutable and cannot be accomplished or pointed out. Ignorance and force of habit exclude the *logos* which is now the prescribed form of proper thought.

> For never shall this be forced through: that things that are not are;
> but restrain your thought from this route of inquiry,
> nor let much-experienced habit force you along this path,
> to ply an aimless eye and resounding ear
> and tongue, but judge by reasoning (logos) the much-battled testing
> spoken by me. [537]

Already in Parmenides proper thought begins to be opposed as *inscrutable*. According to Parmenides *logos* opposes things that '*are not* [which are also said to be] *are'* as *aimless eye and resounding ear* or what Aristotle later framed eloquently as 'contradictory'. However, Aristotle in his Metaphysics Book 4 also writes disparagingly about the Parmenideans who were saying that all reality is one, change is impossible, and existence is timeless and uniform. The Parmenideans believed that nothing about change and motion could truly be said. According to the Parmenideans anything that can be, anything thought, must be eternal and static. Contrarily, Heraclitus' river could not be stepped in even once as the river. The river cannot be the same and static and to think of it as so weirdly other that it could not be stepped in twice would be a lack of restraint of thought.

Aristotle (384-322 BC) much later writes of Heraclitus,

And again, because they saw that all this world of nature is in movement and that about that which changes no true statement can be made, they said that of course, regarding that which everywhere in every respect is changing, nothing could truly be affirmed. It was this belief that blossomed into the most extreme of the views above mentioned, that of the professed Heracliteans, such as was held by Cratylus, who finally did not think it right to say anything but only moved his finger, and criticized Heraclitus for saying that it is impossible to step twice into the same river; for he thought one could not do it even once... 538

Heraclitus is especially critical of the early writer Hesiod (8th century BCE), known as the Father of Greek Mythology in the present day for his Theogony which set down the tales of the Greek gods in written form. Heraclitus complains that Hesiod "did not understand day and night" (DK 57) by which he means that there would be no day without night and yet, in the Theogony, Hesiod writes of the two being distinct from each other with day being `good' and night `bad'.

He is equally critical of philosophers like Parmenides (l. c. 485 BCE) who insisted on a unity of existence which did not admit of change. To Parmenides, the essence of existence was One and plurality was an illusion caused by the senses. If one believed that things changed in life, one was deceived because the essence of anything was uniform and only appearances changed. To Parmenides, a person may appear to grow older but the actual essence of that person could not possibly do so because it was part of the essence of every other person and of all living things everywhere.

Heraclitus thought this was absurd, noting that change is not only apparent but is necessary for the continuation of life. Those who argued otherwise, he claimed, were asleep

> because, "To [the Universe], all things are beautiful, good, and just; but men have assumed some things to be unjust, others just" (Dk 102, Freeman, 31). People fear change because they fear losing what they love but fail to realize that nothing living can remain static and continue to thrive; only living things change and, to Heraclitus, this is their defining characteristic. To reject the concept of change, he would say, is to reject life itself. [539]

Aristotle now regards the 'other' of thought as '*regarding that which everywhere in every respect is changing'* has now reduced Heraclitus' writing as an absurdity in which *'nothing could truly be affirmed'*. The final result is that any exteriority to Heraclitus' thought is simply reduced to the moving of a finger. *Logos* in Parmenides is now framed as absolute which cannot, not be. Therefore, we see a strong and early identification of *logos* with being, existence. Any excess to this harmony which may have underlying Heraclitus' thinking has now for us been whitewashed as the forbidden fruit of good and evil. More historic commentaries on Heraclitus are in Appendix Γ (gamma) – Commentaries on Heraclitus.

With this, the stage has been set for later abstractions in which rationality sets up its inexhaustible limits, its infinity, its inability to *be* anything other than thought. Thought can no longer 'think' an excess to itself. It can only think anachronistically as Heraclitus negatively in the taboo of Parmenidean erratic and random change where nothing could ever be affirmed OR much later Hegelian necessity of change, becoming, the harmonic unity and transformation of opposites OR Nietzsche's life affirming eternal strife. This bi-polar thinking through Western history became the basis of subject and object, matter and mind, and for Hegel immanent opposition and sameness of being and nothingness which becomes.

While understandable, the violent history of the ancient Ionian

philosophers and the embryonic state of the sciences played a role in some of the ancient intuitions of *phusis* getting lost out to glorification of war. However, the glorification of war was not met with unicity.

> Homer's Iliad, a poem about war, does not glorify war: it celebrates valour but also portrays the sufferings caused by war, and Ares, god of war, is rebuked by Zeus as the most hateful of all the gods, to whom strife, wars, and slaughter are forever dear. The same ambivalence pervades Greek attitudes to warfare. War in Greece was a recurrent phenomenon, and conflicts grew in number and scale as larger power blocks emerged. Major wars provide the subject-matter of much of Greek historical writing. There were also countless local wars, less prominent in the record. 'War is the father of all things' (Heraclitus).[540]

Even in Heraclitus (540-480 BC) we find,

> That the father of everything that has come about is generated and ungenerated, creature and creator, we hear him saying:
>
> War is the father of all, king of all: some it shows as gods, some as men' some it makes slaves, others free.[541]
>
> What opposes unites, and the finest attunement stems from things bearing in opposite directions, and all things come about by strife.[542]

Or another source,

> That the father of everything that has come about is generated and ungenerated, creature and creator, we hear him saying:
>
> War is the father of all, king of all: some it shows as gods,

some as men' some it makes slaves, others free.[543]

And again, Heraclitus says,

> What opposes unites, and the finest attunement stems from things bearing in opposite directions, and all things come about by strife.[544]

> Heraclitus has no tolerance for religious ignorance. He does not have any special reverence for gods. He tells us, "Immortals become mortals, mortals become immortals; they live in each other's death and die in each other's life." [545]

For Heraclitus, the apparent world was chaos, strife, war, death. He summed this up as flux. Heraclitus thinks all is fire. Another fragment indicates, "*That which always was, and is, and will be everlasting fire, the same for all, the cosmos, made neither by god nor man, replenishes in measure as it burns away.*"[546] All is flux. Flux is change without an end, a telos. Flux finds no end in becoming. Becoming is not an end itself or a step towards another end. Flux is the end, the beginning, and everything in between. Strife is both war and peace. Detente is merely the cooling of war. Progress is an illusion of fire. When flux is thought this way, it cannot rise above into rationality and Being. Contradiction is a result of rationality. Heraclitus is not yet 'rational' as that history came later. These notions have some similarities and differences between Hegel and Heraclitus. For more information on Heraclitus see "Appendix B (beta) - Fragments of Heraclitus".

On one hand, Hegel identifies completely with the philosophy of Heraclitus and sees in him a kindred spirit who recognizes the true worth of dialectical thinking. Hegel views Heraclitus' philosophy as "the completion of thought (*Bewuesstsein*) before him," which "expresses the essence of the Idea, the Infinite". According to Hegel, what raises Heraclitus's thinking to the highest point of human

reason is that, unlike his critics — the Eleatic philosophers Melissus, Parmenides and Zeno, who see true reality as Being (Sein) only, Heraclitus sees true reality as Becoming (*Werderi*). On the other hand, 'becoming' arising from the dialectical tensions between Being and nothingness for Hegel is progressive. To me, this does not seem to reflect the fundamental ambivalence Heraclitus has toward progress. Let's explore these ideas in Hegel. In Hegel's lecture of "The History of Philosophy" he tells us,

> If we put aside the Ionics, who did not understand the Absolute as Thought, and the Pythagoreans likewise, we have the pure Being of the Eleatics, and the dialectic which denies all finite relationships. Thought to the latter is the process of such manifestations; the world in itself is the apparent, and pure Being alone the true. The dialectic of Zeno thus lays hold of the determinations which rest in the content itself, but it may, in so far, also be called subjective dialectic, inasmuch as it rests in the contemplative subject, and the one, without this movement of the dialectic, is abstract identity. The next step from the existence of the dialectic as movement in the subject, is that it must necessarily itself become objective. If Aristotle blames Thales for doing away with motion, because change cannot be understood from Being, and likewise misses the actual in the Pythagorean numbers and Platonic Ideas, taken as the substances of the things which participate in them, Heraclitus at least understands the absolute as just this process of the dialectic. The dialectic is thus three-fold: (a) the external dialectic, a reasoning which goes over and over again without ever reaching the soul of the thing; (b) immanent dialectic of the object, but falling within the contemplation of the subject; (g) the objectivity of Heraclitus which takes the dialectic itself as principle. The advance requisite and made by Heraclitus is the progression from

> Being as the first immediate thought, to the category of Becoming as the second. This is the first concrete, the Absolute, as in it the unity of opposites. Thus with Heraclitus the philosophic Idea is to be met with in its speculative form; the reasoning of Parmenides and Zeno is abstract understanding. Heraclitus was thus universally esteemed a deep philosopher and even was decried as such. **Here we see land; there is no proposition of Heraclitus which I have not adopted in my Logic**. 547

Here Hegel tells us about something called an external dialect. This is reasoning which can never arrive 'at the soul of a thing'. It merely goes over and over as a sort of abstract infinite regression. Then, a better and later development towards concreteness is called an immanent dialect. This reasoning places all these infinite regressions of externality into a thinking subject and therefore, more concrete. Finally, we arrive at the objective dialectic which no longer has the infinite regression of an external (perhaps metaphysical) object nor the idea in an existing subject but now we have the dialectic which is no longer object and no longer subject - Concept unifies both as the immanent concretization of itself.

Hegel expounds on this just after the quote already given…

> For Heraclitus says: "Everything is in a state of flux; nothing subsists nor does it ever remain the same." And Plato further says of Heraclitus: "He compares things to the current of a river: no one can go twice into the same stream," for it flows on and other water is disturbed. Aristotle tells us (Met. IV. 5) that his successors even said "it could not once be entered," for it changed directly; what is, is not again. Aristotle (De Cœlo, III. 1) goes on to say that Heraclitus declares that "there is only one that remains, and from out of this all else is formed; all except this one is not enduring (pagiwς)."
>
> …

> This universal principle is better characterized as Becoming, the truth of Being; since everything is and is not, Heraclitus hereby expressed that everything is Becoming. Not merely does origination belong to it, but passing away as well; both are not independent, but identical. It is a great advance in thought to pass from Being to Becoming, even if, as the first unity of opposite determinations, it is still abstract. Because in this relationship both must be unrestful and therefore contain within themselves the principle of life, the lack of motion which Aristotle has demonstrated in the earlier philosophies is supplied, and this last is even made to be the principle. This philosophy is thus not one past and gone; its principle is essential, and is to be found in the beginning of my Logic, immediately after Being and Nothing. The recognition of the fact that Being and non-being are abstractions devoid of truth, that the first truth is to be found in Becoming, forms a great advance. The understanding comprehends both as having truth and value in isolation; reason, on the other hand, recognizes the one in the other, and sees that in the one its "other" is contained. If we do not take the conception of existence as complete, the pure Being of simple thought in which everything definite is denied, is the absolute negative; but nothing is the same, or just this self-identity. We here have an absolute transition into the opposite which Zeno did not reach, for he remained at the proposition, "From nothing, comes nothing." With Heraclitus, however, the moment of negativity is immanent, and the Notion of Philosophy as complete is therefore dealt with. [548]

For Hegel, nothingness is the truth of Being. Being as a concept is pure and utmost abstraction. Being is free from any determinations of thought. Yet, we simply assume that 'I am'. In Being's absolute indeterminacy it sets itself up as both the 'not' of

nothingness and, the same as nothingness itself in that abstract Being lacks any determination. This is an absolute contradiction, the "*negative of the negative*". Hegel writes in "The Science of Logic",

> The innermost source of all activity, of all animate and spiritual movement, the dialectical soul that everything true possesses and through which alone is true…. [T]he negative of the negative… is this sublating of the contradiction. Just as little as contradiction is it an act of external reflection, but rather the innermost, most objective movement of life and spirit, through which a subject, a person, a free being, exists. 549

The "*negative of the negative*" is the ultimate contradiction. It is the engine which powers resurrection into life. In Hegel, we see classicism's ultimate "*spiritual*" movement from which logic, the "*sublating of the contradiction*", finally attains its ascension through the dialectic of existence into Being and finally into Concept. Hegel calls Concept the "*most objective movement of life and spirit*". Contradiction is not simply "*external reflection, but rather the innermost, most objective movement of life and spirit*". This is the essence of freedom and existence. Perhaps if Hegel had stated that Concept is a limit of classicism, he would have left the door open for quantum chaos, externality which cannot be recovered.

Instead, Hegel moves ever circularly from Concept back to the inanimate, what Concept must achieve in order to be itself without excess – Concept must forget itself. Concept forgets itself first as a point, a line, a volume – space, then time as repetition of space. Eventually, dialectically towards Being and nothingness and back to Concept. The contradiction and the inevitable transformation, overcoming, rising above while incrementally maintaining contradiction catapults rationality to a limit without any other. How? Binary dualisms are maintained and overcome only for contradiction to yet, once again, claim the day as sublation,

Aufhebung, lifting up. We might think of this as transformation, emergence, and novelty but all in the classical motif. Perhaps we might even find some similarity to complementarity in quantum physics.

But what would quantum chaos, a spooky excess, find in Hegel? For Hegel, excess must always reach for and anticipate a classical limit. Effectively, Hegel denies any such excess to limit which cannot be sublated and overcome transformationally. This is like classical chaos theory which must always find infinitesimals, the 'Butterfly Effect', always maintaining itself in deference, never reachable but always approachable - asymptotic limit. In this way classical chaos theory and classicism's Hegelian pinnacle are absolute causality. Albeit, for Hegel "absolute causality" must be much more technically scrutinized and novelized. Even life itself in Hegel's highly specialized language, very difficult for the average person's understanding, is taken up as 'Concept'. Later, I will explain this further in the section entitled, "A Deeper Dive – Biology, Concept, Hegel, and Quantum Chaos". But for now, Hegel's earlier book 'Phenomenology of Spirit', is an exploration of life as self-consciousness.

'Phenomenology of Spirit' is a philosophical work that explores the development of human consciousness and knowledge. The book marked a significant development in German idealism after Immanuel Kant. Focusing on topics in metaphysics, epistemology, ontology, ethics, history, religion, perception, consciousness, existence, logic, and political philosophy, it is where Hegel develops his concepts of dialectic, absolute idealism, ethical life and Aufhebung. Hegel's goal in the Phenomenology of Spirit was to provide an account of the development of consciousness. The book is a systematic exploration of the various stages of human consciousness and how it evolves over time. Hegel's ultimate aim was to arrive at the concept of absolute knowledge, which he believed could only be achieved through the process of dialectical reasoning. [550] In the Phenomenology, Hegel describes the process of

how consciousness develops from its initial state of immediate sensory experience to a more complex understanding of the world. The book is divided into several chapters, each of which explores a different stage in the development of consciousness. The final chapter, titled "Absolute Knowing," describes the culmination of this process, where consciousness arrives at a complete understanding of itself and the world. [551] Hegel's concept of the Absolute is a central theme in the Phenomenology of Spirit, and it is often seen as a key to understanding the work as a whole. The Absolute is a term that Hegel uses to describe the ultimate reality that underlies all things. According to Hegel, the Absolute is not something that can be grasped directly but must be approached through a process of dialectical development. [552]

Hegel's Phenomenology of Spirit is a complex work that has been interpreted in many ways. Some scholars argue that Hegel considered the work a failure, while others disagree. According to a thesis presented to the University of Guelph, the "Freedom of Self-Consciousness" section of the Phenomenology of Spirit presents the "unhappy consciousness" as it appears in a secular light. The thesis argues that the unhappy consciousness is the inward search for some stable, eternal existence, a search typically understood in light of the religious person's search for God. Whereas Hegel's presentation of this experience is wrapped up in religious language, the significance of his argument is more universal, and the unhappy consciousness can be interpreted in a secular fashion. [553] In any case, Hegel has an important notion of progress which culminates in what he calls 'Concept' in his later work entitled, "Science of Logic".

In his Phenomenology Hegel believed that there is a progressive rational tendency towards life and consciousness in nature, but where and when they will emerge depends on circumstances that are contingent. He also believed that there is a principle of logical evolution in history, which he compared to the growth cycle of a plant. Hegel saw history as following a predetermined logic that

repeatedly led to contradictions and revolutions. In other words, Hegel thought that the universe is progressing towards a higher state of consciousness. He believed that the universe is not devolving, but rather evolving towards a higher state of consciousness.

However, it is not clear from my sources whether Hegel believed that his notion of Concept which was developed later in Hegel's "Science of Logic" was fully realized in his Phenomenology or not. Some critiques believe that Hegel's philosophy is too idealistic and does not take into account the material conditions of society. Critics argue that Hegel's philosophy is too abstract and does not provide practical solutions to the problems of society. They also criticize Hegel's idea of the state as an all-encompassing entity that subsumes the individual. It is ironic that his communist admirers, who thought he fell short of materialism, had similar notions in the practicality of the communist state which was an utter and tragic catastrophe. Some critics even argue that Hegel's philosophy is too deterministic and does not allow for the possibility of change or progress. Some critics of Hegel's philosophy argue that his idea of progressive evolution of becoming is flawed. This latter point is where I see a problem between Hegel and Heraclitus.

Even though Hegel admires Heraclitus greatly I cannot see how his Concept could ever arise from Heraclitus. My point of contention is that Heraclitus' philosophy has no allegiance to Hegel's progressiveness of consciousness. In my estimation,

consciousness for Heraclitus is agathokakological. Agathokakological is an adjective that means composed of both good and evil. The word is derived from the Greek words "*agathos*" meaning good and "*kakos*" meaning bad. Heraclitus is often associated with the term agathokakological. The term is used to describe the belief that good and evil are inseparable and interdependent. Heraclitus was known for his paradoxical philosophy and appreciation for wordplay and cryptic, oracular epigrams. Heraclitus even finds a certain kind of resonance in the

strife of order and destruction, but he never envisions a higher order emerging from strife. Here's a poem inspired by Heraclitus:

The world is in flux, so Heraclitus said,
A river that flows, never the same bed.
The unity of opposites, he did proclaim,
Good and evil, two sides of the same coin.

But good does not absolve evil. Progress cannot 'become' as the result of strife for Heraclitus. Fire cannot become order. In Greek mythology at times, we see gods can order the cosmos. But order as a resonance of fire which overcomes disorder is unique to Hegel not Heraclitus. Heraclitus likens opposite tensions as a musical note.

> Men do not know how what is at variance agrees with itself. It is an attunement of opposite tensions, like that of the bow and the lyre[554]

In the article quoted below we are told that Heraclitus makes an interesting strike against "information-gathering" because it does not "teach understanding".

> Heraclitus made every effort to break out of the mold of contemporary thought. Although he was influenced in a number of ways by the thought and language of his predecessors, including the epic poets Homer and Hesiod, the poet and philosopher Xenophanes, the historian and antiquarian Hecataeus, the religious guru Pythagoras, the sage Bias of Priene, the poet Archilochus, and the Milesian philosophers, he criticized most of them either explicitly or implicitly, and struck out on his own path. He rejected polumathiê or information-gathering on the grounds that it "does not teach understanding". He treated the epic poets as fools and called Pythagoras a fraud.[555]

Heraclitus opposes *information-gathering* to understanding or wisdom, but this is not the classical notion of virtue. Heraclitus believed that opposites are necessary for life, and they are unified in a system of balanced exchanges. Heraclitus is also known for his quote, "*To be even-minded is the greatest virtue. Wisdom is to speak the truth and act in keeping with its nature*". Heraclitus believed that the strife between opposites was justice and that when two opposites warred, they were acting justly. He believed that the apparent peaceful state of rest was impossible without the warring of opposites. Heraclitus used the bow as an example to illustrate this point. He believed that the opposite ends of the bow tried to pull apart, but the bow could not work without that strife. Heraclitus believed that strife was a necessary part of life and that strife had, in a Nietzschean sense, an eternal return of the same which could not be capable of Nietzsche's affirmation of this sense. He believed that the strife between opposites *was* justice and that the apparent peaceful state of rest was impossible without the warring of opposites. It seems to me that quantum physics holds a similar kind of *stasis*, a period or state of inactivity or equilibrium – resonance for Heraclitus. Everett's state reduction or branching does not offer progress in terms of narratives taken from branching. It offers the observer effect. The Heraclitan answer which addresses informational branching of quantum physics is this observation he poses somewhere around 500 BC?

> The most beautiful universe is (a) pouring out (of) sweepings at random.[556]

Heraclitus' most beautiful "*sweepings of random*" are not consummated by progress into Hegel's Concept or even Concept forgetting itself. There is no cycle which repeats endlessly around the circle of becoming into Concept into forgetfulness. For Heraclitus it is random, chaotic. In quantum physics' wave function all these patterns disappear at the limit of complexity where

complexity disappears into chaos without Being/Concept endlessly recoverable. The observer effect affords endless branches into one's narrative together with/as Concepts ascension. In this way there is no progress guaranteed by consciousness. The branching of the observer effect endlessly gives consciousness whatever it desires. Consciousness can entice one to oneself as one, as echo, as one without another.

Empedocles [492-432 BC] understands love and strife as being one and different, coming together and different, "immobile in a circle".

> Twofold is what I shall say: for at one time they [i.e., the elements] grew to be only one
>
> Out of many, at another time again they separate to be many out of one.
>
> And double is the birth of mortal things, double their death.
>
> For the one [i.e., birth] is both born and destroyed by the coming together of all things,
>
> While the other inversely, when they are separated, is nourished and flies apart (?).
>
> And these [scil. the elements] incessantly exchange their places continually,
>
> Sometimes by Love all coming together into one,
>
> Sometimes again each one carried off by the hatred of Strife.
>
> <Thus insofar as they have learned to grow as one out of many,>
>
> And inversely, the one separating again, they end up being many,
>
> To that extent they become, and they do not have a steadfast lifetime;
>
> But insofar as they incessantly exchange their places continually,

To that extent they always are, immobile in a circle.[557]

But Empedocles despises warfare,

> For Empedocles warfare, one fundamental plank of the Greek city state, is the most appalling of all evils and is punished by the immortals by hurling the perpetrators not only out of their society, but out of human society and even down to the level of the lowest forms of nature.[558]

In ancient Rome *virtus*[559] was a specific virtue which connoted valor, masculinity, excellence, courage, character, and worth. Constantine the Great who brought Christianity to Rome in the fourth century AD was an emperor and warrior. He restructured the government and separated civil and military authority. He introduced a new gold coin, the solidus, to combat inflation. Constantine defeated his main rival for the Western emperorship in 312 and defeated the Eastern emperor in 324 after years of strained relations, thus making Constantine sole ruler of the Roman Empire. He would direct largely successful campaigns for the rest of his reign, and he died in 337 while preparing for a campaign against the Persians. Constantine was successful in holding the Roman empire together through a combination of military campaigns, administrative reforms, and religious policies. [560]

After a number of civil wars Constantine brought the empire back together by astutely employing violence and Christianity to hold the empire together. Constantine violently defeated the leader of western Rome, Maxentius, to unite the empire. After Constantine's victory, it was said that the day after the final battle at the Battle of the Milvian Bridge,

> Maxentius body was found and decapitated, and his head was paraded through the streets of Rome before being taken to Africa.[561]

Peter Brown, a scholar of the Roman Empire, is discussed below,

> Brown calls Constantine's conversion a "very Roman conversion." "He had risen to power in a series of deathly civil wars, destroyed the system of divided empire, believed the Christian God had brought him victory, and therefore regarded that god as the proper recipient of religio. He did all of this without according religio to the traditional gods," and Brown says "this is how his subjects came to realize he was a Christian."
>
> Brown says Constantine was over 40, had most likely been a traditional polytheist, and was a savvy and ruthless politician when he declared himself a Christian. His first step after conquering was to eclipse the memory of Maxentius, which he did by filling the center of Rome with monuments such as the Triumphal Arch and the Arch of Constantine. These monuments contain no reference to Christianity. However, in 312, Constantine ordered a statue of himself and Bardill quotes Eusebius as saying Constantine determined his statue should have "a trophy of the Savior's Passion to be set up beneath the hand of his own statue—indeed, he ordered them to place him in the most frequented spot in Rome, holding the saving sign in his right hand." Some time after 324, he wrote to the king of Persia, Shapur II: "Him I call upon with bended knee, shunning all abominable blood and hateful odors [of pagan sacrifice]." [562]

In Rome, the relationship of Christianity and war was forged in a brilliant move which prolonged the Roman Empire. Much later in Western history the fascist atheist Mussolini dispensed of Christianity and simply spoke of the glory of war,

> First of all, as regards the future development of mankind, and quite apart from all present political considerations,

> Fascism does not, generally speaking, believe in the possibility or utility of perpetual peace. It therefore discards pacifism as a cloak for cowardly supine renunciation in contradistinction to self-sacrifice. War alone keys up all human energies to their maximum tension and sets the seal of nobility on those peoples who have the courage to face it. All other tests are substitutes which never place a man face to face with himself before the alternative of life or death. […] The Fascist accepts and loves life; he rejects and despises suicide as cowardly. Life as he understands it means duty, elevation, conquest; life must be lofty and full, it must be lived for oneself but above all for others, both near bye and far off, present and future.[563]

We certainly see this history of war and dominant masculinity which developed from Latin Christianity in which women were denied priesthood and expected to be subservient to their husbands. Most ancient religions from tribal religions, Judaism, Christianity, Islam, Hinduism, and Buddhism have taboos about women and menstruation as impure or unclean.[564]

The glorification and necessity of war and strife over the course of ancient Greek history was the advent of rationalism. As I already mentioned Aristotle near the end of the Classical Period of Greek civilization heralds the principle of noncontradiction. Western history would take up this banner through Rome and into modernity. In rationalism Christianity and violence found coherent voices until eventually Christianity became optional but the glory of war never waned. The necessity of war and strife was forged into the history of rationalism and modernity. For reasons of necessity, noncontradiction found the most ingenious ways to relive itself of the sacred duty of war. Even now the Catholic Church labels itself as ‘pro-life’ but still has the official doctrine of a just war under these conditions,

The damage inflicted by the aggressor on the nation or community of nations must be lasting, grave, and certain;

All other means of putting an end to it must have been shown to be impractical or ineffective;

There must be serious prospects of success;

The use of arms must not produce evils and disorders graver than the evil to be eliminated. the power of modem means of destruction weighs very heavily in evaluating this condition.

These are the traditional elements enumerated in what is called the "just war" doctrine. The evaluation of these conditions for moral legitimacy belongs to the prudential judgment of those who have responsibility for the common good.

Importantly, the conditions are expressly limited to defensive action, after all other options have been exhausted. The Catechism explains that:

(2302 – 2303) By recalling the commandment, "You shall not kill," our Lord asked for peace of heart and denounced murderous anger and hatred as immoral… If anger reaches the point of a deliberate desire to kill or seriously wound a neighbor, it is gravely against charity; it is a mortal sin. The Lord says, 'Everyone who is angry with his brother shall be liable to judgment…' 'But I say to you, love your enemies and pray for those who persecute you, so that you may be sons of your Father who is in heaven.'

(2304 – 2305) Respect for and development of human life requires peace. Peace is not merely the absence of war, and it is not limited to maintaining a balance of powers between adversaries. Peace cannot be attained on earth without safeguarding the goods of persons, free communication among men, respect for the dignity of persons and peoples, and the assiduous practice of fraternity. Peace is 'the tranquillity of order.' Peace is the work of justice and the

effect of charity… He has declared: “Blessed are the peacemakers.’

(2306) Those who renounce violence and bloodshed and, in order to safeguard human rights, make use of those means of defense available to the weakest, bear witness to evangelical charity, provided they do so without harming the rights and obligations of other men and societies…

(2307) …the Church insistently urges everyone to prayer and to action so that the divine Goodness may free us from the ancient bondage of war.

(2308) All citizens and all governments are obliged to work for the avoidance of war. However, “as long as the danger of war persists and there is no international authority with the necessary competence and power, governments cannot be denied the right of lawful self-defense, once all peace efforts have failed. 565

The history of war, rationalism, and noncontradiction of necessity had to find ways to sanctify conquest and its dialectical conspirator self-defense. In this history, ethics had to find its way in the service of truth and Being.

On Nietzsche and his Life in Nineteenth Century Europe

Nietzsche chronicles this fabled history of ethics in his book, “Beyond Good and Evil”,

> In Beyond Good and Evil, Nietzsche accuses past philosophers of lacking critical sense and blindly accepting dogmatic premises in their consideration of morality. Specifically, he accuses them of founding grand metaphysical systems upon the faith that the good man is the opposite of the evil man, rather than just a different expression of the same basic impulses that find more direct expression in the

> evil man. The work moves into the realm "beyond good and evil" in the sense of leaving behind the traditional morality which Nietzsche subjects to a destructive critique in favour of what he regards as an affirmative approach that fearlessly confronts the perspectival nature of knowledge and the perilous condition of the modern individual.[566]

The history which renders ethics subservient to logic is exactly what Levinas addresses. This was the failure of *phusis*. At the current precipice of history, the abyss that stares back at us,

> Battle not with monsters, lest ye become a monster, and if you gaze into the abyss, the abyss gazes also into you.
>
> – Friedrich Nietzsche, Beyond Good and Evil[567]

For Nietzsche, the advent of the *Übermensch* (overman, superman) and the *Letzter Mensch* (last man) pitch the eternal yes-sayer, the unqualified affirmer of the eternal recurrence of the same against the nay-sayer of the final dissolution of man, fatal mediocrity.

> The opposite of the overman [Übermensch] is the last man: I created him at the same time with that. Everything superhuman appears to man as illness and madness. You have to be a sea to absorb a dirty stream without getting dirty.[568]

There is one aspect the *Übermensch* and the last man have in common in which Nietzsche implies an intentional riddle of indeterminacy in what he means could be individual, communities of individuals, or even various epochs. What is eternal recurrence of the same?

> What if some day or night a demon were to steal after you

> into your loneliest loneliness, and say to you, "This life as you now live it and have lived it, you will have to live once more and innumerable times more; and there will be nothing new in it, but every pain and every joy and every thought and sigh and everything unutterably small or great in your life will have to return to you, all in the same succession and sequence" ... Would you not throw yourself down and gnash your teeth and curse the demon who spoke thus? Or have you once experienced a tremendous moment when you would have answered him: "You are a god and never have I heard anything more divine.[569]

For Nietzsche, the endless repetition of the same, exact life over and over for eternity only affords you two choices, the descending despiser of existence or the unqualified affirmer facing what Nietzsche calls in “Thus Spoke Zarathustra”, the great nausea of eternal return.

> Suppose that we said yes to a single moment, then we have not only said yes to ourselves, but to the whole of existence. For nothing stands alone, either in ourselves or in things; and if our soul did but once vibrate and resound with a chord of happiness, then all of eternity was necessary to bring forth this one occurrence—and in this single moment when we said yes, all of eternity was embraced, redeemed, justified and affirmed.[570]

Nietzsche understands the failure of *phusis* to have started at the end of ancient Greek classical period. Nietzsche was not as enthusiastic about Plato’s Socrates.

> We shall turn first, as Nietzsche himself does, to his critical remarks in Twilight concerning Socrates. He begins with the very same sort of criticism with which he began in The Birth

of Tragedy, that Socrates inaugurates a great decline in Greek culture since he was the "murderous principle" of Greek tragedy. Except that by now, still convinced that Socrates represents a decline, Nietzsche broadens the issue considerably. He begins with the affirmation—really a reaffirmation of an oft-repeated claim—that most of the supposedly great sages of history have made a similar judgment on life, "that it is no good" ([10], p. 473), and that moreover, such a judgment on the part of them all is really an indication of decadence. He includes Socrates among these decadents, based initially on what can only be called a curious reading of Socrates' last words on his deathbed in Plato's Phaedo, which Nietzsche mistranslates as "I owe Asclepius the Savior a rooster" ([10], p. 473), and which he interprets as Socrates saying that his life is a sickness. In any case, about Socrates he adds, "The irreverent thought that the great sages are types of decline first occurred to me precisely in a case where it is most strongly opposed by both scholarly and unscholarly prejudice: I recognized Socrates and Plato to be symptoms of degeneration, tools of the Greek dissolution, pseudo-Greek, anti-Greek" ([10], pp. 473–74), and he even cites parenthetically The Birth of Tragedy in support of this. So, Socrates is still paradigmatically a symptom of decline, although now, it is less specifically as the murderer of tragedy and more generally as one of those so-called sages who evaluates life badly, or rather, as Nietzsche insists, that they think that life can be evaluated at all ([10], p. 474).

To support this, it is on Socrates' supposed decadence that Nietzsche first concentrates. He cites, as evidence of this, Socrates' notorious ugliness ("Ugliness, in itself an objection, is among the Greeks almost a refutation" ([10], p. 474)), his plebeian background, but most importantly and consistent with his evaluation in The Birth of Tragedy, the

> “hypertrophy of the logical faculty” and “that Socratic equation of reason, virtue, and happiness: that most bizarre of all equations, which, moreover, is opposed to all the instincts of the earlier Greeks” ([10], p. 475). We have seen these themes in the earlier text. Here, Nietzsche concentrates his attention on the so-called Socratic optimism about reason and “dialectic”, by which Nietzsche seems to mean what is often called the “Socratic method” of questioning established views to see if they can withstand Socrates’ elenchus. Such demand for reasons and dialectical proof Nietzsche now interprets as a form of “bad manners”, dishonesty, and in any case not relevant to genuine insight. “What must first be proved is worth little” ([10], p. 476), he says famously. But by now Nietzsche, steeped in his commitment to what he calls his “genealogy”, is most interested in the psychology of such an insistence on reason giving, on what experience of life gives rise to such a commitment. And he decides that it is an instance of the spirit of revenge. 571

Nietzsche also accuses Plato of over-morality, implying that Plato’s moral framework is excessively rigid and dogmatic. He goes so far as to call Plato an “exalted swindle”, suggesting that Plato’s ideas are deceptive or misleading. Nietzsche also draws a parallel between Christianity and Platonism. He claims that Christianity essentially represents a form of Platonism for the masses, with its harmful moral values. Nietzsche challenges Plato’s perceived hatred of life, arguing that humans should value life despite its inherent suffering. Plato’s works often rely on deductive reasoning and first principles. In contrast, Nietzsche tends to reason from an inductive stance, emphasizing empirical evidence and a more dynamic approach to understanding the world. 572

In his work “The Birth of Tragedy”, Nietzsche criticized Aristotle’s views on tragedy. Specifically, he focused on the relationship between the tragic emotions of pity (*eleos*) and fear

(*phobos*)—both of which are painful experiences—and the aesthetic result of the art of tragedy. Nietzsche claimed that Aristotle made two errors in his formulation of the tragic experience and especially the concept of catharsis. He believed that Aristotle misidentified both pity and fear, leading to a flawed understanding of their role in tragedy. He misunderstood the concept of catharsis, which Nietzsche believed meant "purgation of emotions" [573] Beyond tragedy, Nietzsche also engaged in broader discussions about logic. He denounced logic but directed his antilogic polemics primarily against semantics. Nietzsche regarded semantics as being committed to a realist metaphysics, which he abhorred. His critique was not aimed at logical syntax or proof theory per se, but rather at the underlying metaphysical assumptions. He took issue with logicians who naively accepted realist semantics. [574] Nietzsche's objections to Aristotle's logic spanned both specific issues related to tragedy and broader philosophical concerns about metaphysics and semantics.

Nietzsche questioned the aesthetic result of tragedy. He referred to it as "the proper pleasure of tragedy" (*he oikeia hedone tes tragodias*). In contrast to Aristotle, Nietzsche's perspective on tragedy emphasized a deeper connection between the painful emotions and the artistic experience. Nietzsche's critique of Aristotle's views on tragedy highlights their differing perspectives on the emotional and aesthetic dimensions of this art form. While Aristotle's catharsis theory has been influential, Nietzsche offered an alternative interpretation that challenged traditional notions of tragedy. [575]

When it comes to logic and the principle of noncontradiction, Nietzsche's stance is very unusual by today's standards. Nietzsche is infamous for denouncing logic itself. However, it's essential to recognize that his criticisms are not directed at logical syntax or proof theory. Instead, he takes aim at semantics, which he perceives as being entangled with a realist metaphysics. In other words, Nietzsche challenges the assumptions underlying how we

understand and express meaning. The heart of Nietzsche's antilogic polemics lies in his rejection of metaphysical realism. He contends that logic rests on assumptions that do not correspond to anything in the real world. For instance, the assumption of the equality of things or the identity of the same thing at different points in time is, according to Nietzsche, divorced from reality. His critique extends beyond mere formal reasoning; it delves into the very nature of existence. Nietzsche's criticisms of logic occupy a peculiar place in the annals of philosophy. Over the past century, knowledge of and sensitivity to logic have become prerequisites for serious philosophical inquiry. Yet Nietzsche's iconoclastic stance challenges this orthodoxy, urging us to question the very foundations upon which our rational systems rest. Nietzsche's relationship with logic is complex. While he may appear as a logical nihilist, his critiques are more nuanced, targeting semantic commitments and metaphysical assumptions. His legacy invites us to engage with the tension between reason and reality. 576

Nietzsche thought that Judaic history, and its ancestor Christianity, as memorializing slavery, a demented logic, what he called descending morality. This decadence fits with his notion of Plato and Aristotle as the end of the greatness of the Greeks. However, at the end of the history of the Greeks in logic he still sees logic as a parting gift of the greatness of the Greeks and not the later decadence of the resentment of life, the ignoble morality. In "Thus Spoke Zarathustra" Nietzsche uses his eternal recurrence of the same as a litmus test of Greek morality. In eternal recurrence of the same everything we ever did in our life was endlessly repeated the exact same way sort of like the movie "Groundhog Day" with not even the possibility for changing the daily sequence. Nietzsche thought noble morality of the Greeks would affirm existence even if it had to be lived forever the same way. But slave morality which crystalized from logic as the last great gasp of the Greeks would resent existence. While Nietzsche lost his mind in 1890 and died in 1899, Hitler in the Third Reich, decades after Nietzsche, was all too

willing to utilize the overman as an example of the 'beauty' of the Third Reich. Interestingly, Nietzsche later in his life despised the rise of the Second Reich in Wagner. In any case, his philosophy shows us a very clear picture of how Nietzsche's later romanticizing from the elite heights of 'Beyond Good and Evil' has been used as a springboard for violence and war. Even when Zarathustra leaves his blissful mountain top, he says, "I must go down as the human beings say, to whom I want to descend." For Nietzsche his thesis of 'gay science' rationalism and antithesis of decadent morality provided much fodder for the canons of war and violence to come forty years after his death in 1900. But whether he meant it or not his 'ascendent morality' has been overtaken by vacuous pretensions towards elitism.

Nietzsche in "The Birth of Tragedy" introduced the concepts of the Apollonian and the Dionysian. These terms represent opposing tensions in art and are named after two Greek gods: Apollo and Dionysus. The peak of Apollonian and the Dionysian ritualism took place around the 6th century BC. Apollo, the Olympian deity, is revered as the god of light, music, poetry, healing, plagues, prophecy, knowledge, order, beauty, archery, and agriculture. His significance extends beyond mere physical prowess; Apollo represents the ideal of *kalokagathia*, which encompasses harmony, reason, and moderation—a harmonious blend of moral virtue and physical excellence. Apollo leads the Muses, inspiring humans in arts, poetry, and music. Examples include sculpture, which embodies pure form and order. As a patron god, he symbolizes harmony, reasoning, and moderation—the epitome of the Hellenic ideal of *kalokagathia*. Apollo's multifaceted nature extends to purification, healing, and medicine. His arrows, while capable of destruction, also serve to ward off harm for those he favors.

On the other hand, Dionysian named after Dionysus, the god of wine, dance, pleasure, irrationality, and chaos represents deeply emotional and ecstatic art. Dionysus is associated with passion, emotions, and instincts. Dionysus embraces disorder, intoxication,

and unity. Dionysus involves the dissolution of boundaries and liberation of instinct. The Dionysian ritualistic festivals had ecstatic forms of worship. In their rituals they practiced intense and unrestrained orgies (orgia, ὄργιον), masked dancing by torchlight, animal sacrifice, snake handling, all while highly intoxicated. Their goal was to liberate individuals from inhibitions and social constraints, allowing them to return to a more natural state. [577]

Nietzsche believed that the fusion of these two forces—Apollonian and Dionysian—formed dramatic arts or tragedies. The ancient Greek spectators, when confronted with the abyss of human suffering depicted on stage, passionately affirmed life, finding it worth living. Tragedy, according to Nietzsche, combined both elements, allowing the audience to experience the full spectrum of the human condition. The Apollonian represents order, clarity, and individuation, while the Dionysian embodies chaos, ecstasy, and the dissolution of boundaries. [578]

Nietzsche was a very complicated, nuanced philosopher. Unlike many philosophers, even today, he did not feel the need to publish and defend until death do us part. He had varying and conflicting ideas depending on when and which publication he was working on. This did not seem to bother him in the least. For the sake of this book, I want to explore his ideas about democracy.

Nietzsche had multifaceted views on democracy, particularly when it came to the context of Athenian democracy. Women, children, and slaves were permanently disqualified from citizenship under Athenian democracy. Early on Nietzsche rejected democracy. In his unpublished essay titled “The Greek State,” Nietzsche initially rejected democracy as detrimental to culture. He saw it as a system that could potentially undermine the flourishing of higher values and individual excellence. During this early period, Nietzsche viewed democracy as incompatible with the cultivation of a refined and elevated culture. In Nietzsche’s middle period he shifted a bit. In his so-called “middle period” works (such as Human, All Too Human), Nietzsche’s stance was more mitigated. He began to see

democratic ideals and institutions as necessary foundations for and protectors of mediocrity so that exceptional culture could flourish. In this way, Nietzsche recognized the potential of democracy to provide a stable backdrop for human development and creativity. Rather than outright rejection, he acknowledged that democracy could play a role in fostering exceptional cultural growth. Nietzsche's perspective on democracy was not monolithic. Some commentators have emphasized the agonistic aspects of his thinking, suggesting a Nietzschean form of democracy that embraces struggle and conflict. Others have focused on the aristocratic dimensions in Nietzsche's thought, which often stood in contrast to democratic principles. Overall, Nietzsche's attitude toward Greek antiquity was highly positive, considering them "the only people of genius in world history" in his notebooks. Nietzsche's views on democracy were complex, ranging from early skepticism to a more nuanced recognition of its potential impact on culture and human development. No one claims that Nietzsche himself was much of a democrat. His denunciations of modern democracy and liberal equality are legion. What is generally not disputed is that Nietzsche's main rejection is for the egalitarian 'spirit' of democracy, not democratic institutions themselves. 579

Let's take a step back and look at the 19th century historic setting in which Nietzsche lived and how he reflected on it. Slavery was still practiced and widespread in his lifetime. Nietzsche criticized the emancipatory movements of the 19th century that sought to free various groups from oppression. In an unpublished note, he expressed disdain for the emancipation of women, slaves, workers, and the sick. Nietzsche believed that such emancipation would lead to the "levelling of European man" and contribute to the decay of contemporary European culture. Nietzsche specifically mentioned Harriet Beecher Stowe, the author of the anti-slavery novel "Uncle Tom's Cabin". He criticized Stowe as a follower of Jean-Jacques Rousseau's false gospel of man's natural goodness and equality. By denouncing Stowe's humanitarian ideals, Nietzsche

took an unpopular stance in late 19th-century Germany. His stance echoed a popular master-slave dialectic of a contemporary Georg Wilhelm Friedrich Hegel. Nietzsche's exploration of morality includes the concept of slave morality. Slave morality values sympathy, kindness, and humility and is associated with the herd. In contrast, the noble master transcends mediocrity and imposes their own values. This conflict between slave and master morality shaped society's history according to Nietzsche. Nietzsche saw slavery as an enduring facet of human existence. He considered it a barometer of modern society's physiological well-being and a repository for externalities. Slavery became an important hallmark of the industrial culture. [580]

Additionally, I do not know anywhere in which Nietzsche expressed an opinion about the printing press, but I would think he may have thought of it as a greater vehicle for mediocrity of the masses. One other thing to note is that Nietzsche did have friends, donors and sponsors which helped him survive rather meagerly. He also had some family support and very early in his career before he was banished from academia due to his PhD dissertation, "The Birth of Tragedy", he had an academic position in Basel where he received a small stipend. His books were never popular during his lifetime. His sister Elisabeth Förster-Nietzsche took care of him during the last ten years of his life when he lost his mind, believed to be a result of a syphilis injection when he was younger. [581] Elisabeth Förster-Nietzsche was two years younger than her brother, Friedrich Nietzsche, and outlived him by thirty-five years. In 1901, a year after Nietzsche's death, she published The Will to Power, a hasty compilation of writings he never intended for print. [582]

In 1885, Elisabeth married Bernhard Förster, a former high school teacher who had become a prominent German nationalist and antisemite. Friedrich Nietzsche did not attend their wedding, and their relationship grew apart after the marriage. Together, they embarked on an ambitious but ultimately unsuccessful venture: creating a colony called Nueva Germania in Paraguay in 1887. In

the 1930s, Elisabeth Förster-Nietzsche became a supporter of the Nazi Party. Scholars have debated her role in falsifying Nietzsche's work to align it with Nazi ideology. Some accounts suggest that she edited Nietzsche's writings to emphasize racist and eugenicist themes, but this remains a topic of scholarly discussion. Adolf Hitler himself attended her funeral in 1935. After Elisabeth's death, scholars reexamined Nietzsche's writings. They found that some of Elisabeth's versions were distorted and spurious. She had even forged nearly 30 letters and frequently rewrote passages. While Elisabeth Förster-Nietzsche's relationship with Bernhard Förster and her later alignment with the Nazi Party are well-documented, the extent of her influence on Nietzsche's work remains a subject of ongoing debate in scholarly circles. 583

Other important events during Nietzsche's lifetime were the breakdown of Feudal systems where aristocrats ruled Europe. The decline of serfdom played a crucial role. As serfs gained more freedom, they could no longer be bound to the land and forced labor. This shift disrupted the traditional feudal relationship between lords and peasants. Privatized farming emerged as landowners turned to profit-driven agriculture. Instead of relying solely on feudal obligations, they began seeking economic gains through market-oriented practices. The rise of capitalism challenged feudal structures. Capitalist principles emphasized individual ownership, free markets, and economic self-interest. These ideas clashed with the collective landholding and hierarchical system of feudalism. Enlightenment thinkers advocated for individual rights, liberty, and equality. Their ideas encouraged the questioning of traditional authority and paved the way for social and political reforms. The Industrial Revolution transformed economies, leading to urbanization and the growth of cities. Factory-based production shifted the focus away from rural agricultural estates. Urban centers became hubs of commerce, industry, and new social dynamics. The feudal system struggled to adapt to these changes, as its agrarian foundations were ill-suited for an industrialized world. Legal

reforms gradually dismantled feudal privileges. Land reforms, abolition of serfdom, and changes in property rights weakened the feudal order. Social movements advocating for equality, workers' rights, and democratic governance gained momentum. These movements challenged the entrenched power structures of feudalism. The rise of nationalism encouraged the formation of unified nation-states. Feudal lords lost their autonomy as centralized governments asserted control. Constitutional reforms and revolutions (such as the French Revolution) aimed to replace feudal hierarchies with more egalitarian systems. The term "feudalism" itself emerged in the 19th century as historians, economists, and lawyers sought to describe past systems and structures. 584

The German Confederation was established in 1815 after the dissolution of the Holy Roman Empire. It comprised 39 predominantly German-speaking sovereign states in Central Europe. The Congress of Vienna aimed to create a stable balance of power in the region. Notable members included Austria and Prussia. The German Confederation laid the groundwork for later developments, including the eventual unification of Germany. 585

In Nietzsche's lifetime the German Confederacy led to the unification of Germany and the Second Reich. The German Empire, also known as Imperial Germany or the Second Reich, existed from the unification of Germany in 1871 until the November Revolution in 1918. It marked the transition from a collection of independent states to a unified nation-state. The unification was achieved through diplomatic agreements and the leadership of Prussia within the North German Confederation. The German Empire was characterized by a monarchy until it transformed into a republic after World War I. 586

In the first section of Nietzsche's Zarathustra he writes,

> When Zarathustra was thirty years old, he left his home and the lake of his home, and went into the mountains. There he

enjoyed his spirit and his solitude, and for ten years did not weary of it. But at last his heart changed,—and rising one morning with the rosy dawn, he went before the sun, and spake thus unto it:

Thou great star! What would be thy happiness if thou hadst not those for whom thou shinest!

For ten years hast thou climbed hither unto my cave: thou wouldst have wearied of thy light and of the journey, had it not been for me, mine eagle, and my serpent.

But we awaited thee every morning, took from thee thine overflow, and blessed thee for it.

Lo! I am weary of my wisdom, like the bee that hath gathered too much honey; I need hands outstretched to take it.

I would fain bestow and distribute, until the wise have once more become joyous in their folly, and the poor happy in their riches.

Therefore must I descend into the deep: as thou doest in the evening, when thou goest behind the sea, and givest light also to the nether-world, thou exuberant star!

Like thee must I go down, as men say, to whom I shall descend.

Bless me, then, thou tranquil eye, that canst behold even the greatest happiness without envy!

Bless the cup that is about to overflow, that the water may flow golden out of it, and carry everywhere the reflection of thy bliss!

Lo! This cup is again going to empty itself, and Zarathustra is again going to be a man.

Thus began Zarathustra's down-going. 587

Nietzsche Contra Marx

Contrary to the descent of Nietzsche's Zarathustra from high air and

noble morality Karl Marx (1818–1883) breathes the 19th century air of polluted industrial England. Karl Marx was a German philosopher, economist, political theorist, historian, sociologist, journalist, and revolutionary socialist. [588] Karl Marx never personally engaged in acts of violence. The main ideological fight Marx had was against the feudalism of his day in Europe and the pseudo capitalism of aristocrats and autocracy in the mid to late 19th century industrial capitalism with issues like child labor, environmental destitution, extremely low wages and working hours, deadly working conditions resulting in black lung and other horrible worker health, and high worker death rates. [589] Marx was a philosopher. His philosophical writings against Hegel and others reflected a natural, non-violent evolution from European feudalism coupled with industrial capitalism, to socialism to communism. Marx' ideological fight was against the brutal feudalism of his day in Europe and especially England. Remember we had a violent revolutionary war against a feudalistic autocracy with England. We also received support from European allies and revolutionary fighters and naval support from Europe. Decades later, well after the death of Marx, the Bolsheviks in Russia took the route of bloody communism to the detriment of humanity and the cause of leftists ever after. Here is just one example of how Marx is not understood these days:

Often wrongly quoted out of context was a remark Marx made when he was 30 years old, wrote in his newspaper, "*there is only one way in which the murderous death agonies of the old society and the bloody birth throes of the new society can be shortened, simplified and concentrated, and that way is revolutionary terror*."[590]

From 1848 to 1849 a number of revolutions took place against the horrific monarchy of the Austrian Empire. The Germans, Hungarians, Slovenes, Poles, Czechs, Slovaks, Ruthenians (Ukrainians), Romanians, Croats, Venetians and Serbs all tried to achieve Nationalistic autonomy from the German Confederation [591] of which the Austrian Empire was a prominent member. [592]

That quote above was addressed by Marx on November 6, 1848, after Croatia had “won the day, and this victory was celebrated with arson, rape, looting and other atrocities.” It was a criticism of Windischgratz, Auersperg and Jellachich:

- Windischgratz - a brutal Austrian monarch named Windischgratz, [593]
- Auersperg - a very old aristocratic princely family aligned with the Austrian monarchy, [594]
- and Jellachich [595] a Croatian lieutenant who fought for independence against the Austrian monarchy in 1848. [596]

Actually, Marx liked ‘America’, meaning the United States, and believed that after our Civil War defeated slavery, we might have a very different path to income equality. In his letters Marx wrote:

> A people's war [our Civil War] of this sort, on both sides, is unprecedented ever since the establishment of powerful states; its outcome will doubtless determine the future of America for hundreds of years to come. As soon as slavery — that greatest of obstacles to the political and social development of the United States — has been smashed, the country will experience a boom that will very soon assure it an altogether different place in the history of the world, and the army and navy created during the war will then soon find employment.
>
> The workingmen of Europe feel sure that as the American War of independence initiated a new era of the ascendency for the middle-class so the American anti-slavery War will do for the working-class. The workingmen of Europe feel sure that as the American War of independence initiated a new era of the ascendency for the middle-class so the American anti-slavery War will do for the working-class.[597]

Marx shared the budding great American hope. Marx saw a place for capitalism in socialism. His hope for America as "*a new era of the ascendency for the middle-class so the American anti-slavery War will do for the working-class.*", was not monolithically against capitalism but the inequities which harbor themselves in capitalism and the aristocracies of his day. We have also failed miserably to defeat the un-American Jim Crowism which has lingered on to the present day.

Marx knew nothing about the absolute evils to come of communist Russia. Economic hardship, food shortages, and government corruption contributed to disillusionment with Tzarist Czar Nicholas II. The Industrial Revolution brought immense social and political changes, but Russia lagged behind Western Europe and the United States. Overcrowding and destitute living conditions affected Russian industrial workers. Frequent food shortages plagued the vast empire due to population growth and harsh growing seasons. The devastating Russo-Japanese War weakened Russia and Czar Nicholas II's position.

Georgy Valentinovich Plekhanov (1856-1918) actually introduced Marxism to Russia. Plekhanov, a Russian revolutionary and Marxist philosopher, played a pivotal role in introducing Marxism to Russia. Plekhanov argued that Russia was undergoing capitalistic development, leading to the conditions for overthrowing Russian autocracy and establishing a *bourgeois-democratic* regime. Plekhanov was a Menshevik, opposing the Bolshevik seizure of power in Russia in 1917. [598] The Bolsheviks were the more violent and extreme faction, led by Vladimir Lenin. Bolsheviks believed in a violent revolution to overthrow the existing government and establish a socialist state. They advocated for a proletarian dictatorship and the centralization of power. The Mensheviks were the more moderate faction. Mensheviks believed in a peaceful, democratic transition to socialism. They favored collaboration with other socialist groups and a gradual approach to social change. The Bolsheviks aimed for an immediate revolution, seizing power

through armed struggle. Their slogan was “Peace, Land, and Bread.” The Mensheviks advocated for patience and a long-term strategy. They believed in working within the existing political system and building a broad-based coalition. The Bolsheviks eventually gained power during the October Revolution (1917) and formed the Soviet Union. 599

The Bolsheviks, led by leftist revolutionary Vladimir Lenin, played a crucial role. After overthrowing the Russian autocracy, Lenin advocated for a Soviet government directly ruled by councils of soldiers, peasants, and workers.

> Lenin did not favour moving toward a socialist economy after October, because the Bolsheviks lacked the necessary economic skills. He preferred state capitalism, with capitalist managers staying in place but supervised by the workforce. Others, like Bukharin, wanted a rapid transition to a socialist economy. The Civil War caused the Bolsheviks to adopt a more severe economic policy known as War Communism, characterized chiefly by the expropriation of private business and industry and the forced requisition of grain and other food products from the peasants. The Bolsheviks subsequently clashed with the labour force, which understood socialism as industrial self-management. Ever-present hunger exacerbated the poor labour relations, and strikes became endemic, especially in Petrograd. The Bolsheviks, however, pressed ahead, using coercion as necessary. 600

Contrary to Lenin’s opinion and some other factions including labor groups, the Bolsheviks did not aim for a gradual transition. Instead, they sought to establish a communist state immediately. The Bolsheviks seized power, occupied government buildings, and formed a new government with Lenin as its head. Lenin became the dictator of the world’s first communist state. The Bolsheviks later

evolved into the Communist Party of the Soviet Union. The horror of communist Russia and Nazi Germany rank among the highest evils in modern history. However, any violence Marx wrote about should only be considered wrong if we are willing to say that our violence against England in the Revolutionary war to overthrow the feudalism of England was wrong as well. Marx did take a keen interest in the economic and social conditions of the Tsarist empire. His work, Das Kapital, was translated into Russian in 1872. During Marx's time, Russia was under the Tsarist regime of the Romanovs. This period aligns with the feudalist stage in Marx's economic determinist framework. Under this system, the Tsar owned the land and delegated it to nobility, who, in turn, exploited peasants through a practice known as serfdom. 601

Vladimir Lenin (1870-1924) was only thirteen years old when Marx died. Lenin adapted Marx' ideas during the Russian revolution which overthrew the absolute monarchy of the Russian Tsarist regime. Lenin, a pivotal figure in Russian Marxism, further developed and applied Marxist principles to the specific context of the Russian Empire. His contributions shaped the course of history and laid the groundwork for the Russian Revolution and the subsequent establishment of the Soviet Union. Marx himself did not directly witness the Russian Empire but his ideas and theories had a lasting impact on the country through the work of subsequent thinkers like Lenin. 602

Nietzsche's Legacy

Besides a few academics Nietzsche has found some acceptance on the part of pop culture and politically oriented elitists. In our era of nihilism, as Nietzsche observes, the impetus to long, to desire, has devolved into cynicism, skepticism, sophistry, and negativity. For Nietzsche, Greek mythos was a motion which begins in overflowing passion and activity but ends as a historically necessary nemesis of affectively depleted rationalism of logic and truth. However,

Nietzsche's legacy did not usher in a grand new era of affirmation of life but, whether deserved or not, the horror of the meaninglessness of life. It may be a tragic irony that the whimper of his 'last man' of mediocrity may reflect more upon the subsequent elitists of power than a renaissance of the Übermensch. And his most adamant devotees seem to be young men who exude an excess of testosterone in their elitist pontifications. The higher virtues of the overcomers function in the same way the 'logic' of a decadent God can always appeal to a higher God. Likewise, the decadent higher types can always appeal to a higher type which they imagine themselves to be.

Fanaticism as we see in our epoch is only the frenetic gasp of nihilism which does not meet existence with welcoming desire but dissolves it in putrid disdain. This is not what gave us metaphysics but what metaphysics has given us. The metaphysical logic of Western history reduces otherness to the drab same, the doldrums of absolute equivocation, and thus 'end' is not telos, culmination, completion, fulfillment as *kairos* but whimper and oblivion which Nietzsche may well be what he termed the 'last man' but unbeknownst to him would simply be yet another endless repetition of nihilism as the Übermensch. Nietzsche failed to see how even his Übermenschen glowing overcomers today think they are pathetic overcomers. For Nietzsche, another beginning which thinks deeply about the confluence and clash of classicism and modernity does not take us past the byways of Hesiodic chaos but towards the overcrowded paths of self-glorification, elitism, and horrific violence. In this then do we see that philosophy, science, art, and religion find their glorious *telos* once again for the first time in all the noble romanticization's of Nietzsche?

> In our era of nihilism, as Nietzsche observes, the impetus to long, to desire, has devolved into cynicism, skepticism, sophistry and negativity. It is a retraction from the motion which begins the passion and activity of Truth and its

necessary nemesis. 603

Ironic that nihilism has also been shown to be the inevitable outcome and necessary nemesis of the noble romanticization's of Nietzsche's promise of the Übermensch. The Übermensch does not grow from the uncertainty of chaos in the infancy of the ancient Greeks. The overcoming of the Übermensch has not spawned itself as glorious allusions from tragic privation. Nietzsche's highest man which faces tragedy and privation without denying it but affirming it as the greatest virtue is one of noble elitism.

The table below shows how Nietzsche distinguishes between the rare great ones and the all-too-common inferior types.

Decadent Morality	**Affirmative Morality**
Happiness	Suffering
Altruism/Selflessness	Self-love or self-interest
Equality	Inequality
Pity/Compassion	Indifference to the suffering

604

With respect to the decadent morality column in the table above, the moral pejorative sense (MPS), Nietzsche argues either the MPS has no intrinsic value (in the cases where MPS claims it does) or that the MPS does not have any or not nearly as much extrinsic value as the MPS treats it as having. More simply, happiness, altruism, selflessness, equality, pity, and compassion are highly overrated.

With respect to the affirmative morality column, Nietzsche argues only that the suffering, self-love, self-interest, inequality, and indifference to suffering are valuable for the cultivation of human excellence, a condition for the highest 'men', and that all of this is obscured by the rabble of decadent morality. 605

In Nietzsche's 'righteous' inequalities its aftermath in history

made oppression of inferiority into the greatest virtue. However, Levinas finds this logic consumed with essence, *being and non-being*, Being and Nothing. Nietzsche has no place for an exteriority to classicism except as denial of one for the other. It still maintains the decadence of the logic it denounces.

> One has to find for man another kinship than that which ties him to being, one that will perhaps enable us to conceive of this difference between me and the other, this inequality, in a sense absolutely opposed to oppression. Such a reconsideration is hardly conceivable in a world where infidelity to Nietzsche, even conceived outside of all National-Socialist contaminations, is (despite "the death of God") taken as blasphemy. But does the subject escape the concept and essence, anxiety over death and horror of the there is, only in resignation and illusion, against which at the hour of truth or of the inevitable awakening essence is stronger? Can one not understand the subjectivity of the subject beyond essence, as on the basis of a leaving the concept, a forgetting of being and non-being? 606

Levinas finds bipolar dualities in Nietzsche which still adhere to the logic it despises, the inescapable essence of values condemned to evaluation and re-evaluation. Heraclitus is not the philosopher of eternal recurrence of the same, whether it is affirming or resenting essence as Nietzsche imagines. Nietzsche tells us that the greatness of the Greeks consisted in the affirmation of life, ascending values, an overcoming evident in the Greek tragedies.

> According to Heraclitean strife, the Greek contest, and Nietzsche's will to power, a balancing out of opposing forces is never achieved, otherwise the struggle which fuels existence would die out. The struggle must never be extinguished; opposing forces must continue the battle, each

> overcoming the other in turn, for all eternity. This is the way in which the eternal recurrence serves as a prescription for the overman. The will to power, mankind's unrefined animosity and envy, must be acknowledged by the strong individual and transformed from a nihilistic force into one of positive ambition and increase. The eternal recurrence is what the overman strives for within himself; since the rules of eternal becoming, of the contest, do not apply to humanity by nature. Each individual must choose whether to enter into the eternal contest or to extinguish the struggle with his will to power by denying his passions. The eternal recurrence and will to power fit together in that it is the belief in eternal recurrence which gives great individuals the strength to acknowledge the potential of this terrible drive as a source of elevation and increase.[607]

He contrasts this to the despising and resentment of life which he tells us started in Judaism and was perfected in Christianity. Nietzsche follows Heraclitus' glorification of war and strike as a heroic affirmation of the Great Nausea (from "Thus Spoke Zarathustra") of existence. Nietzsche tells us the high point of the Greek affirmation of life is in Dionysian festivals of wine, dance, and pleasure. Dionysus is the god of chaos and destruction, war and strife. Dionysus is associated with the dark, the underworld. This association caused the Dionysian to associate the female with wild/ chaotic nature and unconstrained sex and procreation. However, the chaos of Dionysus is not the chaos of Heraclitus which is flux and the river which cannot be stepped into twice. Neither is it the chaos of the quantum wave function, the observer effect, and branching into classicisms. Heraclitus and quantum physics both cannot find an enduring, absolute basis of sameness. The Dionysian is more akin to contemporary aspirations towards uninhibited freedom amounting to pure self-indulgence. Both Dionysus and Apollo are brothers of Zeus. Zeus is the god of sun, art, music,

poetry, plague, and disease. Apollo is the god of moderation, logic, and reason. Both sects reveled in the masculine and discounted the feminine according to Camila Paglio.[608] Paglio tells us that the struggle of Apollo to Dionysus became a quarrel of the cortex and the limbic and reptilian brain. In Western history the Apollonian ethic won out.[609] Nietzsche tells us in “Twilight of the Idols/The Anti-Christ”,

> In this state one enriches everything out of one's own fullness: whatever one sees, whatever one wills, is seen swelled, taut, strong, overloaded with strength. A man in this state transforms things until they mirror his power--until they are reflections of his perfection. This having to transform into perfection is--art. Even everything that he is not yet, becomes for him an occasion of joy in himself; in art man enjoys himself as perfection.[610]

However, for Nietzsche all of this exists to and from classical physics. The idea here rests on the fact that in an infinite expanse of time, given temporality proceeds from a past to a future, everything at some far-off point will be repeated over and over again in exactly the same way forever. Therefore, the only choice is affirmation in the face of eternal return.

Quantum physics tells a different story from physics. Levinas tells a radically different story of philosophy. In both of these stories there is no ‘same’, no past towards endless futures which must always be the same, only an excess which can be faced or retreated from. The downfall of the history of rationalism is its assumption of a particular kind of physics as absolute in which we must make friends with the horror,

> Horror has a face and you must make a friend of horror. Horror and moral terror are your friends. If they are not, then they are enemies to be feared. They are truly enemies.

Horror is the next eternal moment that can never end after Zarathustra's final affirmation that "*all of eternity was necessary to bring forth this one occurrence—and in this single moment when we said yes, all of eternity was embraced, redeemed, justified and affirmed*". The 'yes' in us and all things echoing away after "*all of eternity was embraced, redeemed, justified and affirmed*" must forever reverberate in the gaze towards nothingness. The nothingness of nothing left to do…only the sheer stare of 'there is' which claims 'affirmation'. The horror of one's face without another is the horror of 'oneness in itself'. It is the horror from which one cannot turn one's gaze. The horror of Narcissus is the 'one without an other', any other. It is simply the eternal gaze where nothing else exists except gazing. Gazing cannot close its eyes. Gazing cannot see as there is nothing to see. Gazing can only persist in the vacuousness of Orpheus' blank stare in which Eurydice fades forever into sheer gaze's impossibility to die, to submerge itself in sleep and nothingness.

But before Nietzsche's final 'affirmation' of self's overcoming, is it possible that overcoming extinguished an excess in which seeing was blinded to what could not resound back to oneself, towards an other which the Übermensch could not absorb in its eternal glee? What if his gaze of all eternity blinded an alterity whose gaze could never see. Certainly, in the branching of the wave function all of Nietzsche's fall into his observation of eternity might have missed an other not gaze-able, information lost forever to gaze. And this is not some God, metaphysic, or 'reality' which is subsumed in 'my all'. Only responsibility holds open a place for what cannot 'be' interior to 'me' and neither in the domain of all my exteriors, my "*whole[s] of existence*" however they may present themselves to all my *Beings*.

On the way through quantum physics, we encountered a trace of our inability to even be able e.g., find easily accessible meanings, answers, where only a void remains in our attempts to draw from

our repository of potential understandings. We have seen from quantum mechanics that *Being* may fall with our observations only to repeat and reverberate itself over and over again as 'reality'. Radical exteriority is not religion, belief, faith, but a trace of a hint which emerges from the spooky chaos of quantum physics. There is a response to this chaos, this abyss we face which cannot *be* effaced with ourselves, our gaze. Later we will see that the evocation of radical alterity presents us with responsibility. Levinas calls this responsibility in the face of the other Ethics.

The Hidden Sufficiency of Being

With all this in mind I will return to the statement I previously made that physics has proven in many ingenious and sophisticated experiments that the state of the water-tops is not just mathematical uncertainty - it ***is*** the uncertainty of all possibilities occurring at once in '**reality**'.

Notice the use of the words 'reality' and 'is' in the previous statement, *it **is** the uncertainty of all possibilities occurring at once in **'reality'**, **is*** exactly what a major thesis of this book is all about. Are we not awkwardly doubling down yet again by subsequently writing, yet again, *'**is** exactly what a major thesis of this book is all about'*? This is not an accidental coincidence. Let's notice a kind of circularity in our use of the word '**is**' which is repeated in both statements. '**Is**' **is** the present tense, third person singular of the verb 'to be'. This awkwardness built into the structure of Western language is a circularity fundamentally built into language which we automatically and unawares simply assume. We name this circularity 'Being'. Being encapsulates and obfuscates chaos, unaccounted-for excess. We use it all the time as if we all know what it means. We think of being in all its grammatical forms as a kind of filler word which means nothing but somehow needs to be used to make sense of our sentences. We will come back to this later in the discussion of Martin Heidegger. For now, let's notice that

there is an awkwardness in language to even explicate, in linguistic terms, what mathematical, experimental, even 'empirically proven' evidence has told us over the last century about "the dominant trait of quantum physics". The circularity we are seeing is not from quantum physics. It is from language which is the product of history. The notion of 'Being' is the fundamental bedrock upon which our Western language is built on. It is so submerged in language that we use it all the time as if it were an invisible 'given', a forgotten inheritance of our history – simple commonsense. As we will see for Levinas this circularity thrusts upon us the violence of war. Levinas also understands this violence especially in the way Hegel takes up subjectivity only to lose it as 'Concept'. Levinas calls this self-authorizing origin in the repetition of Being, in the small and almost disappearing words 'to-be' (is, are, was, etc.) functioning like engrams lost from its history - the reverberation of Being (which forms the basis for the practical *modus operandi* of the science of marketing).

According to physics there is an externality to what '**is**' which cannot be accounted for in 'common sense'. Common sense is another name for obfuscating times that were not our lived time, not in our lived space, *in our lifetime*, the lost, submerged into and as a repetition of my lived history. An obfuscation which can and must *only* order and arrange the very way in which we navigate our lived life as if there were not any pasts which my past could not subsume, no pasts which I have not accounted for in my understanding, not forgotten but subsumed in the histories of the 'I am', assumed and validated by me as 'our orientation'. Ironically, what we do and 'are' as 'reality' has now been dissolved by the very anchor of 'reality' many of us believe as science, as fact, as what is true. This is no longer mere 'philosophizing' according to the common edict of common-sense. Let's call it supposition and informational branching. I hope through the course of this book we may glimpse an externality which will give us pause. Perhaps a lapse in what other might face us. We will come back to all this

later in the discussion of Heidegger and Levinas.

Explanations for Quantum Weirdness

There have been many attempts to explain quantum weirdness. In this section I want to explain some of the other ways which have been proposed. Some of these explanations try to align with general relativity. First, let's look at a few basics about special relativity and cause.

Special Relativity (1905) described a flat spacetime, [612] utilizing Minkowski Space (1908)—a flat 4D geometry with no gravity. However, it was Einstein's application of General Relativity in 1917 that led him to propose a static universe model, a view he held until Hubble's data in 1931.[613] While Special Relativity was flat, Einstein's 1917 model described a curved spacetime (specifically a hypersphere). Yet, the philosophical implication of both theories—that past, present, and future exist simultaneously—came to be known as the Block Universe (or later, Eternalism).[614]

In its simplest sense relativity has four dimensions, one of time and three of space. In the block universe there is no preferred direction of time like past, present, and future. The 'time' dimension is encoded as one axis in a four-dimensional spacetime coordinate system. Minkowski stated as early as 1908 that,

> The views of space and time which I wish to lay before you have sprung from the soil of experimental physics, and therein lies their strength. They are radical. Henceforth space by itself, and time by itself, are doomed to fade away into mere shadows, and only a kind of union of the two will preserve an independent reality.[615]

Let's say 'x' is width, 'y' is height, 'z' is depth, and 't' is time. All points in this spacetime coordinate system are given by (x,y,z,t). There is no preference between coordinates that has any priority

over any other preference. We can say that all the coordinates have a symmetry with each other. Effectively, this means that there is no causality, no causal direction of time which takes precedence over the spatial dimensions. This is highly abstract and hard to visualize. However, any event that took place at (t1) could not only be thought of as a cause in space (x1,y1,z1) creating an event in space (x2,y2, z2) at (t2) but could also be thought of as an event at (t2) in space (x2,y2, z2) creating a cause at time (t1) in space (x1,y1,z1). In the first instance we would call that causality and in the second instance we could call that 'retrocausality'. Causality has no direction in the block universe.

In 1917, when Einstein published his general theory of relativity, he still had a static universe but curved spacetime, which we call gravity, required a curved universe.[616] Curved space required Einstein to use a more generalized form of Minkowski space which allowed more dimensions than four called Lorentzian manifold.[617] In April 1931, Einstein finally agreed that the universe was expanding.[618]

Our experience of the world or reality is causal. The traditional way we think about causality is as an initial cause and then effect going forward in time. Einstein's relativity tells us that time is symmetric around all four axes. Time can go forward and backward in the block universe. In the block universe of Einstein time is an illusion. Einstein said,

> Albert Einstein once wrote: People like us who believe in physics know that the distinction between past, present and future is only a stubbornly persistent illusion. Time, in other words, he said, is an illusion.[619]

When we think of the word 'static', as in Einstein's static universe, we may think of it as finite. But static does not necessarily mean finite. Contrarily, relativity has infinites. Blackholes or what Einstein called a Schwarzschild singularity[620] severely warped

spacetime creating singularities which imply infinity. Einstein denied several times that they physically existed.

> The essential result of this investigation is a clear understanding as to why the "Schwarzschild singularities" do not exist in physical reality. Although the theory given here treats only clusters whose particles move along circular paths it does not seem to be subject to reasonable doubt that more general cases will have analogous results. The "Schwarzschild cannot be concentrated arbitrarily. And this is due to the fact that otherwise the constituting particles would reach the velocity of light.[621]

The force of gravity or spacetime in Schwarzschild singularity curvature extends infinitely. So, this appears to imply that a static block universe contains infinites like blackholes and gravity. These infinites should be thought of as limits where an approach to a limit can be made closer and closer to the limit, infinitesimally closer, but can never reach the actual limit. This is called by physicists asymptotic. As mentioned in the quote above, one reason Einstein opposed the physical existence of blackholes is that he thought a singularity would actually reach the speed of light not just approach it. The eternalism of the block universe has always been a point of high contention for physicists. How can the block universe explain our sense of time, our sense of cause and effect? How would we know the mechanism, the actual physics, which explains the symmetry of the block universe? Without our classical idea of causality having a priority in nature, our machine-like physics (or better metaphysics) falls apart like a junky old car rusting away. To complicate the time problem even more Einstein published his EPR paper entitled “Can Quantum Mechanical Description of Physical Reality Be Considered Complete?” in 1935 putting forward the time problem of quantum entanglement. Einstein worked the rest of his life to try to substantiate locality using hidden variables. Even in

Einstein's failure he proved that the 'spooky' must be real. This brings me back to one way physicists tried to keep Einstein's ghost alive in his hidden variables theorem.

Pilot-wave theory tells us that there are hidden variables which explain how all this spookiness and non-locality works. However, contrary to Einstein's hope, pilot-wave theory also tells us we can never know how all these hidden local variables work. We know that the mechanism of our observation changed the course of our experiment while in progress which in turn caused the start of the experiment to change which affected what we ended up seeing. Would this imply a mechanism that can go backwards in time but still validate our notion of cause along with that pesky retrocausality? What if waves were instantaneously propagating forward and backward in time while the experiment was going on and continually renegotiating an outcome depending on what the observer was looking for? Ok a bit of a brain teaser but it does maintain a relativistic framework with the impossibly hidden local variables adhering to the absolute speed limit of light. One other gotcha about this is the trivial matter that locality cannot be maintained in pilot-wave theory. This is because that pesky coordinate 't' punches spooky holes in the other 'x', 'y', and 'z' coordinates because 't' has no preference for the locality of 'x', 'y', and 'z' and... 't' is always equal to zero from start to end of the entangled property.

We have an assumption that reality is real whether we observe it or not. This is contrary to findings in quantum physics. The ontological problem is the problem of, is 'reality' real? Is there 'real' existence, is there an '*is*' or do we need to ask ourselves and come to terms with some notions which make us uncomfortable and disorienting? Let's cut to the chase, here it is,

> An odd space experiment has confirmed that, as quantum mechanics says, reality is what you choose it to be. Physicists have long known that a quantum of light, or photon, will

> behave like a particle or a wave depending on how they measure it. Now, by bouncing photons off satellites, a team has confirmed that an observer can make that decision even after a photon has made its way almost completely through the experiment—seemingly well past the point at which it would become either a wave or a particle. Such delayed-choice experiments might someday probe the fuzzy frontier between quantum theory and relativity, researchers say.[622]

These experiments show that a delayed choice can be made by the observer while the experiment is underway which determines the outcome of the experiment. With this in mind I want to explore the notion of retrocausality.

Retrocausality

Does retrocausality exist ontically or in reality? If so, what are the motivating factors for determining what retrocausality would mean? Retrocausality has been invoked by philosophers and physicists. Some of the most brilliant physicists who have ever lived understood that retrocausality could be a possible outcome, but they resisted reconciling themselves to such a conclusion. It seems to me the resistance to retrocausality for some is that it would have implied some sort of absolute 'subjectivity' along the order of Berkeley's principle of *esse est percipi* [essence is perception or to be is to be perceived]. The whole notion of subjectivity was antithetical to the scientific method. Yet, the 'objective' as 'reality' has motivated some to find a way into the quantum conundrum of retrocausality.

I will try to simplify these ideas as best as I can. They are very difficult and non-intuitive. I only include this to give a flavor of how difficult these ideas are. I hope you can see why some of the greatest minds in history were haunted by their own inquiries into phenomena. Phenomenology in 20th century philosophy was also

contemporaneously asking these earth-shattering kinds of questions in the same mode as, for example, what shows itself in human experience (i.e., the experience of time and space not the abstraction of the experience of time as linear and space as extension).

Two Motivations for Retrocausality

Retrocausality does not exclude non-locality. Quantum physics agrees even maintaining that events in particle physics go back and forth from non-locality to local events zigzagging back and forth. This zigzag effect is called 'action-by-contact'.

There are two motivations for thinking that retrocausality might be ontic, exist in reality:

1. Exploiting Loopholes in the "No-Go Theorems"
2. Time-Symmetry

These will be discussed in the next two sections.

Exploiting Loopholes in the "No-Go Theorems"

No-go theorems must necessarily be accounted-for loopholes in established principles of quantum physics if anyone wants to maintain retrocausality. These no-go theorems are unique to quantum mechanics and diametrically oppose concepts maintained in classical physics. Here are the basic no-go theorems:

- Nonlocality – retrocausality is compatible with spacetime that is not local
- Contextual – retrocausality is influenced by the context of the observation
- Indeterminism - retrocausality is set by all, some, or a mixture of possibilities

Locality means not only are events in quantum physics 'nearby' but they can also include causes and effects that are no further away than the speed of light. While the correlation is instantaneous (non-local), no usable information is *transmitted* faster than light, thus preserving causality. While this might seem like a technicality, entanglement violates *locality* (correlations happen instantly), but it does **not** violate *causality* or the *no-signaling theorem*. You cannot use entanglement to send a message faster than light. There are some that contest this as we will see but this is not the general consensus. There is no doubt that violation of these conditions, e.g., instantaneous, non-local, in exformation has been verified in quantum physics. This alone makes quantum physics incompatible with relativity where the speed of light rules. This also means that violations of locality are completely due to some particular setup that an experimenter has prior to conducting the experiment. Super-determinism is a belief that something an experiment did prior to setting up the experiment influenced the wavefunction completely deterministically. If this were true, the outcome of the wave function would not be probabilistic as the outcome would be completely determined by the experimenter and the wavefunction. This also works if the experimenter is said to have had some future effect which completely determined the outcome of the experiment. Certainly, the observer exercises and influences the wave function but is not a super-determiner of the result of the experiment. If super-determinism were true, it would be a form of action-by-contact. If super-determinism is false, then there may be nonlocal events which can still display statistically causal results. One obvious case of this is qubits. If qubits had no causal predictability even though qubits are nonlocal, quantum computing would not be possible.

Contextuality is the observer effect. But if repetitions of an experiment can provide statistically significant results, then a kind of non-contextuality can be thought of as pseudo-causal. This gets back to Leibniz' idea of Identity of Indiscernibles. An easy way to

think about this, for every x, there is a y such that y is the sufficient reason for x. However, for quantum physics, we should probably just say, there is a statistical probability depending on spooky observation.

There has been a long, protracted argument in quantum physics as to whether or not the wave function is real, ontic, and simply a part of reality. Or is the wave function a result of experimental preparation? If this is so, then the argument is about whether or not the experimenter's incomplete knowledge of the wave function. This is the epistemic argument. However, if statistically reproducible results can be obtained then there is no measurement independence in which the result of the experiment can never be determined. If measurement independence is true, then retrocausality is prohibited.

All of these loopholes show that there is some capacity for causality and retrocausality in quantum physics.

Deriving Retrocausality from Time-Symmetry Principle

Time-symmetry means that at the most fundamental level the Standard Model of Elementary Particles is CPT-Invariant. CPT-Invariant means,

- The laws of charge reversal stay the same when we replace all particles with their antiparticles.
- The laws of parity stay the same when flipping the signs of all spatial coordinates.
- The laws of time-reversal stay the same.

If time-symmetry holds these laws should stay the same whether we are going forward or backward in time. If time-symmetry holds then retrocausality must also be true.

Retrocausality as nonlocality, contextualism, or indeterminate is fundamentally different from classical physics. Classical physics

assumed locality in absolute space. There was nothing outside of temporality understood as a linear sequence of 'now' moments always and eternally spanning a past towards a future and validating cause and effect. Reality was non-contextual in classical physics. It was objective, not affected by our observation of it. Reality was understood as fundamentally determinate with the caveat that understanding was not complete. *Phusis*, becoming nature, becoming machine always played by the same rules. Our job was to discover all the rules. The Western assumption of progressivism led us towards better and better understanding, advancement, adaptation, and evolvement. Retrocausality threw all that into chaos. Any explanation of retrocausality must be ontic. It must have a physical component in existence. Most important, it must have time-symmetry meaning it must be consistent with special relativity and the spacetime symmetric block universe.[623]

As we saw, relativity is symmetric for time and space. This necessarily implies that the laws of physics are the same or invariant in all relative frames. Therefore, any discussion of retrocausality must assume that time-symmetry and space-symmetry are valid. The problem is how to explain retrocausality ontically meaning as it exists in time and space. For retrocausality at least one of the three conditions, nonlocality, contextuality, or indeterminism must be true. I will discuss this more later, but entanglement is not contingent on locality. However, entanglement is real, it is ontic, it happens in existence yet has no inherent dependence on space as linear distance or time as classic physics and how we normally think of time.

Entanglement as *the characteristic trait of quantum mechanics* necessarily implies that nonlocality is a necessary given of quantum mechanics. The role of the observer in co-determining 'reality', what is observed, is also a given of the quantum wave function. This is called contextuality. The observer is a necessary part of the context of 'reality'. Indeterminism arises in 'reality' as fundamental in the uncertainty principle. By 'fundamental' I mean not a

placeholder for lack of knowledge. So retrocausality can only survive as a reconstitution of cause and retrocausality while remaining faithful to at least one of these characteristics of entanglement. Any one of these conditions reflexively pushes back on our notion of Being or existence. Its implication pushes back on ontology, the history of Being.

The 'is' of Being, existence, reality named by all the linguistic variations of ***to-be (is, being, existence, am, are, was, were, be, been),*** …is indeterminate. Notice again the way ***is*** necessarily reverberates, repeats itself, in an awkward and abrupt fashion when trying to think quantum physics (nonlocality, contextualism, indeterminate). In naming 'is' we already pull down a hermeneutics, an interpretation, which explains, soothes, relaxes, turns off a quantum narrative, which *is* cumbersome. Something very important in this will become apparent later on, which is why I keep bringing it to your attention.

Interesting enough, Huw Price believes retrocausality can only be ontically [in terms of being, existence, or 'reality'] explained in terms of the symmetry of time. He thinks this because at least some aspects of the quantum wave function have 'real' effects in space or ontological effects. My way of thinking this is that if the wave function did not have real effects, it would either be metaphysical or purely mathematical. Also, experiments are conducted with initial inputs and outputs measured across time so in some way they are through time, symmetric or ontological.

> Price turns these sketchy considerations into a rigorous argument. He shows that, when combined with two assumptions concerning quantum ontology, time-symmetry implies retrocausality (understood along broadly interventionist lines). The ontological assumptions are
>
> that at least some aspects of the quantum state ψ [symbol for the quantum wave function] are real (notably, in Price's example, there is a "beable" [ability to be] encoding photon

> polarization angle), and that inputs and outputs of quantum experiments are discrete emission and detection events. Moreover, it is important to Price's argument that dynamical time-symmetry (that the dynamical laws of the theory are time-symmetric) be understood as implying that operational time-symmetry (that the set of all possible combinations of preparation and measurement procedures in a theory, with associated probabilities for outputs given inputs, is closed under interchange of preparation and measurement) translates into ontic time-symmetry (operational time-symmetry plus a suitable map between the ontic state spaces of the symmetric combinations).
>
> Given these conditions, any foundational account that reproduces the empirical verdicts of quantum theory must be retrocausal.[624]

The result of meeting Price's conditions is that ontology would necessarily imply retrocausality. I will explore some of the ideas for retrocausality below.

Action Duality

The explanation is highly mathematical based on Lagrangian, path integral-based, formalism. The bottom line is that complementarity in all its many quantum forms must remain intact in all its ontological symmetries or its way of showing itself in 'reality'. This is called action duality. Action duality necessarily implies that entangled particles and non-entangled particles, for example, two entangled photons passing through a polarizer and a single photon passing through a polarizer, must have the same causal and retrocausal explanation. So, for example, non-locality for entangled particles also applies to unentangled particles.

Notably, Evans, Price, & Wharton (2013) argue that there is

> such an action symmetry between a pair of entangled photons passing through separate polarizers and a single photon passing sequentially through two polarizers. Thus, if action duality is well-founded, the action symmetry should be reflected in identical ontologies for the action-dual experiments. Short of rejecting action duality, this implies one of two things: either the usual causal explanation for the behavior of the single photon must be reflected in a causal explanation for the typically-quantum behavior of the pair of entangled photons, and so there must be retrocausality at the level of the ontic state λ, or the nonlocality ascribed to the typically-quantum behavior of the pair of entangled photons must be similarly ascribed to the behavior of the single photon, and so nonlocality is even more dramatically widespread than usually assumed, and indeed is not unique to entangled bipartite quantum systems.[625]

Any explanation of reality must consider how a single particle can ever become entangled. In action-duality, there must be something about non-entangled particles that are already configured as entanglement-ready.

The Transactional Interpretation

The transactional interpretation for retrocausality appears to be the most popular at the current time. This interpretation was influenced by two very famous physicists John Wheeler (1911 to 2008) and Richard Feynman (1918 to 1988). The transactional interpretation suggests that there is some kind of causal-retrocausal negotiation which is forward evolving and backward evolving. It is a kind of repetitive handshake between the beginning of an event and the end of an event. The motif given is an emitter and an absorber as both sides of the event or transaction. One example of this negotiating process happens in neutron beta decay. In neutron beta

decay a neutron decays to a proton an electron and an anti-neutrino. This process is a negotiated process as we discussed above which happens in less than a billionth of a billionth of a billionth of a second. The process cannot be observed.[626] However, the transaction must include the role of the observer. The observer has a role to play as integrated with the emitter. In superposition all possibilities are simultaneous realities. The observer in the processes of observing, emitting together with the experimental apparatus, determines how the negotiation will go. Since all this occurs instantaneously, without time, there is a strong implication that it all occurs in a pseudo temporal process which is not a process at all but only used as a "pedagogical convention for the purpose of description".

> At the heart of the transactional interpretation is the "transaction": real physical events are identified with so-called "handshakes" between forward-evolving quantum states ψ and backward-evolving complex-conjugates ψ^*. When a quantum emitter (such as a vibrating electron or atom in an excited state) is to emit a single quantum (a photon, in these cases), the source produces a radiative field —the "offer" wave. Analogously to the Wheeler-Feynman description, this field propagates outwards both forward and backward in time (as well as across space). When this field encounters an absorber, a new field is generated—the "confirmation" wave—that likewise propagates both forward and backward in time, and so is present as an advanced incident wave at the emitter at the instant of emission. Both the retarded field produced by the absorber and the advanced field produced by the emitter exactly cancel with the retarded field produced by the emitter and advanced field produced by the absorber for all times before the emission and after the absorption of the photon; only between the emitter and the absorber is there a radiative

> field. Thus the transaction is completed with this "handshake": a cycle of offer and confirmation waves repeats until the response of the emitter and absorber is sufficient to satisfy all of the quantum boundary conditions…at which point the transaction is completed.
>
> Many confirmation waves from potential absorbers may converge on the emitter at the time of emission but the quantum boundary conditions can usually only permit a single transaction to form. Any observer who witnesses this process would perceive only the completed transaction, which would be interpreted as the passage of a particle (e.g., a photon) between emitter and absorber.[627]

It appears that the absorber has a kind of passive role just waiting for the result to be negotiated. If this is the case for retrocausality, the absorber is always passive until the emitter initiates the negotiation process. In the case of the photon going through two slits, there are two absorbers (detectors), so to preserve retrocausality there must be some kind of confirmation wave sent back to the emitter. But how can an emitter absorb the conformation without having a dual nature as both absorber and emitter? The emitter in the case of the double-slit experiment is a laser somehow in consortium with the observer. But how can a laser absorb? Also, let's not forget Heisenberg's uncertainty principle. Any and all transactions must have uncertainty and probability built into the outcome, what the detectors detect. This implies that the negotiation process must be probable and not fully deterministic as well. So, it must be possible that negotiations can be unsuccessful. How would that show up as *either* an interference pattern (a wave) or a single point (a particle)? Additionally, experiments have shown that while the experiment is in process the observer effect can be applied in mid-course to change the outcome of the experiment. Can negotiations be changed mid-course?

There is an alternative explanation for retrocausality that the

quantum process takes place in a 'block world'. This is Einstein's block universe. This seems to me to simply rely on Einstein's mathematical abstraction as simply the way it is. This makes reality an abstraction with no concrete way to get back to reality or ontology. In a way, it is sort of like just invoking the name of God to explain reality. Are we just supposed to say, "Oh, now I see. It was God whose name is Minkowski."

Developments Towards a Retrocausal Model

The transactional interpretation is the most prominent model for retrocausality. There are some other models which will be explored below.

Two-State Vector Formalism

This information relies on two state vectors, one evolving forward and one evolving backward, which have incomplete information. Basically, we have two states. There is a forward evolving quantum state which must be supplemented by a backward evolving quantum state. Each completes the other.

> The proposal is that the usual forward evolving quantum state contains insufficient information to completely specify a quantum system; rather the forward evolving state must be supplemented by a backward evolving state to provide a complete specification. Thus, according to the two-state vector formalism, the complete quantum description contains a state vector that evolves forward in time from the initial boundary condition towards the future, and a state vector that evolves backward in time from the future boundary condition towards the past.[628]

Apparently, it does not really specify the role of the observer. It

simply has a starting state and an ending state which evolve in both temporal directions. The ontological element in which the observer affects the states is not really given from what I can see.

Toy Models

This model also has causal bi-directionality or causal and retrocausal. This model is hard to follow but I will give it a shot. The model has three primitive internal nodes and five external nodes. Each of the three internal nodes meet at the point of three edges with two internal edges linking the three nodes and five external edges. Each edge has one of three flavors, *A*, *B*, or *C*. The system is temporally oriented with three external nodes, each joined to a single edge, representing system inputs (preparations/ interventions), and two system outputs (measurement outcomes/ observations) joined to the remaining two edges. The two internal edges represent hidden flavors that cannot be directly controlled or observed. There are two basic rules that govern the dynamics of this toy system:

- each node must be strictly inhomogeneous—i.e., comprising three edges of different flavors—or strictly homogeneous—i.e., three edges of the same flavor.
- successive homogeneous nodes are prohibited. 629

The two system outputs are affected by measurement outcomes and observations. The three external edges which are joined to a single edge are affected by experimental setup and interventions into the experiment. Retrocausality comes from the hidden edges which correlate between input states and hidden states (could we think hidden variables?). The hidden states depend retrocausally input states and are part of the past. The input variables have interventions from a distant output variable in a kind of non-local manner.

> Price suggests a simple toy model featuring linked nodes that can assume different values, which he dubs the “Helsinki model”. If one interprets the nodes as partially ordered in time and the values of the exogenous boundary nodes as controllable, the dynamics specified by Price entails causal bi-directionality, i.e., both ordinary forward causality and retrocausality, understood in an interventionist sense. Although the model does indeed display particular behavior that can be naturally interpreted as retrocausal, a full-blown analogy with standard quantum mechanics is limited.[630]

Two-Time Boundary Model

This model depends on the thermodynamic model of time, the arrow of time we think of as entropy. Remember that there is information which can be derived about a system depending on its amount of entropy. Also, heat is information which is chaotic but can be used for work. For example, it can power turbines for producing electricity. In this model there are microstates and macroscopic states or what I will call macrostates. The system always has some sort of thermodynamic process occurring. This thermodynamic process is a kind of feedback which plays a determinative role in experimental outcome. The chaotic heat is a kind of disjointed memory of past possible states. These past possible states allow a plethora of dynamically evolving prior microstates. There is a winnowing process which takes place in retrocausality due to the interdiction of the most successful of these past microstates. The microstates have a probability effect on the macrostate outcome of the system. Because of the thermodynamic arrow of time, this is an asymmetric process. While the final macrostate state has an uncertain dependence on the past thermodynamic feedback of possible states, the initial microscopic state of the system is conditioned by the future state of the system. These hidden microstates which have retentions of all possible

states seem to me to again be closely associated with hidden variables.

> Schulman proposes a solution to the quantum measurement problem based on the possibility of future conditioning, which originates from his analysis of the thermodynamic arrow of time. Beginning with Loschmidt's challenge to Boltzmann—that it should not be possible to derive irreversible dynamical behavior from time-symmetric dynamics (see the entry on thermodynamic asymmetry in time)—Schulman notes that successful "retrodiction" of past macroscopic states of some thermodynamic system is indeed asymmetric to successful "prediction" of future macroscopic states. For successful retrodiction, rather than evolving each of the microscopic states of some macroscopic state according to the dynamical laws (which is identical to the process of prediction, and is the basis of Loschmidt's challenge), one instead hypothesizes a prior macroscopic state to which the prediction process can be applied such that the current macroscopic state of the system obtains with high likelihood given the dynamical evolution of the prior microscopic states. With respect to the set of possible microscopic states for the current macroscopic state, since the evolution of the vast majority (on Liouville measure) of these states according to the dynamical laws result in trajectories that conflict with the retrodiction hypothesis, these states are effectively rejected in the process of retrodiction in favor of those special few microscopic states that correspond to the dynamical evolution of acceptable hypothetical initial conditions.[631]

From what I can tell, the observation component of this model comes from the future conditioning and cryptic results which might be more like emergent results from some form of metastability. In

other words, the thermodynamic memory of all possible states is not fully deterministic. Unexplainable mutations of microstates in the chaos of thermodynamic heat can get cryptically interwoven to create fully novel states. This reminds me analogically of evolution and its accidents (or perhaps Aristotle's accidents). The experiment controls the macroscopic states. Because of chaotic thermal processes much of the microscopic states are not decipherable, I think. Anyway, I find this one interesting in utilizing thermodynamic information as chaotic, unassembled information, which can somehow influence microstates from both the past and the future. This seems to have some possibilities made actual from exformation.

All-at-once Lagrangian Model

This model takes a classical approach using differential equations to characterize boundary conditions of an initial event and a final event. It characterizes a unified solution to a two-time boundary value problem. A boundary is an equation which characterizes a system in terms of a range of observed and measured possibilities which have definite inputs and outputs. The unified solution is where it gets its name as it results in a field solution using only mathematical differential equations derived from the initial and final event boundary conditions. Think of the weather at time x as a small packet of air. If we know certain pre-existing conditions such as high- and low-pressure fronts and temperature, we can construct a model of how the air packet will move through an initial and final time and space. This model is called a field like an electromagnetic field.

> The account is a retrocausal picture based on Hamilton's principle and the symmetric constraint of both initial and final boundary conditions to construct equations of motion from a Lagrangian, and is a natural setting for a perspectival

> interventionist account of causality. Wharton treats external measurements as physical constraints imposed on a system in the same way that boundary constraints are imposed on the action integral of Hamilton's principle; the final measurement does not simply reveal preexisting values of the parameters, but constrains those values (just as the initial boundary condition would). Wharton's model has been described as an "all-at-once" approach, since the dynamics of physical systems between an initial and final boundary emerges en bloc as the solution to a two-time boundary value problem.[632]

However, since this is a quantum function there are unknown contextual parameters or parameters related to observation. This results in a probability distribution over the field equations. This model is retrocausal because the probabilities over groups of field trajectories are influenced by future measurement time and setting.

Arguments Against Retrocausality

There have been many arguments against retrocausality. This section will look into various arguments against retrocausality.

General Arguments Against Retrocausality

Let's say we know that a quantum physics experiment can be devised in which a cause can produce a statistically significant effect or result.

Experiment in Time ->

Cause	Effect (result)
Ontic (an agent actually starting the experiment)	Epistemic (expected result)

It should be possible then to devise an experiment in quantum mechanics in which the apparent statistical effect can happen earlier in time that does not produce the expected cause.

Experiment in Time ->

Effect (result)	Cause
Ontic (an agent actually starting the experiment)	Epistemic (expected result)

If retrocausality is true, it should not be possible that the effect happening earlier in time does not produce the cause. This is called the bilking argument because the effect bilked out the cause.

The argument against the bilking is that just because the agent can start a cause which produces an effect does not mean that an agent can start the effect to produce the cause. The reversal of the ontic and the epistemic may not be possible but that does not disprove retrocausality. The agent may have epistemic access to the effect and not have epistemic access to the cause. It may be that epistemic access is not reversible. If the wavefunction includes the condition that the result must be epistemic, then it cannot be ontic. Ok, this goes against our common idea that it either ‘is’ or ‘isn’t’. We assume that both cause and effect have to be actual, ontic, ‘real’ but this is spooky quantum physics so we cannot assume that to be the case.

No-Signaling Requirement for Entanglement

Causality is a big problem in quantum mechanics. Retrocausality is an effort to retrieve causality where it can be retrieved. One given assumption of this effort is that causality can never be completely retrieved since, for one, entanglement has been proven to be non-causal. The faithfulness assumption is that every statistical independence implies a causal independence. In other

words, if the statistical model or repetitive measurements cannot find statistical correlations, non-causality is assumed. The faithfulness assumptions require that no signaling occurs between particles. However, if a causality claim is made it must be fine-tuned. By fine-tuning what is meant is that a causal assertion must violate the faithfulness assumption.

> More precisely, according to them, since the observed statistical independences in an entangled bipartite quantum system imply no signaling between the parties, when it is then assumed that every statistical independence implies a causal independence (which is what faithfulness dictates), it must be inferred that there can be no (direct or mediated) causal link between the parties. Since there is an observed statistical dependence between the outcomes of measurements on the bipartite system, we can no longer account for this dependence with a causal link unless this link is fine tuned to ensure that the no-signaling independences still hold. There is thus a fundamental tension between the observed quantum correlations and the no-signaling requirement, the faithfulness assumption and the possibility of a causal explanation.[635]

The No-Signaling principle governs experiments like the Delayed Choice Quantum Eraser, ensuring that the interference pattern is only recovered after correlating the data (i.e., the user cannot see the future in real-time). In interpretations involving retrocausality (such as Cramer's Transactional Interpretation), this preservation of causality requires a 'handshake' or fine-tuned negotiation between future and past states.

Retrocausality requires fine tuning of some kind, such as, for example, negotiations. However, this

Formally, Wood and Spekkens argue that the following three

assumptions form an inconsistent set:

> the predictions of quantum theory concerning the observed statistical dependences and independences are correct;
>
> the observed statistical dependences and independences can be given a causal explanation;
>
> the faithfulness assumption holds. Wood and Spekkens conclude that, since the faithfulness assumption is an indispensable element of causal discovery, the second assumption must yield. The contrapositive of this is that any purported causal explanation of the observed correlations in an entangled bipartite quantum system falls afoul of the tension between the no-signaling constraint and no fine tuning and, thus, must violate the assumption of faithfulness. Such causal explanations, so the argument goes, including retrocausal explanations, should therefore be ruled out as viable explanations.[636]

It seems like common sense to assume that entangled particles communicate through a medium of particles between two entangled particles. However, physicists have proven that there is no immediate path in which signals between the two entangled particles travel. In fact, Feynman's idea that all the paths are traversed in superposition collapsing as a result is generally accepted among physicists. I would think that if retrocausality were real or ontic it would also have to traverse all paths at once.

In addition, it has also been proven and accepted that there is no faster than light signaling between the particles as well.[637] The only room left for signaling or negotiating which could be detected is below the zero-point energy levels into the Planck sizes. However, the real issue here is that between the no-signaling constraint and no fine-tuning requirements there is no wiggle room to avoid violating the assumption of faithfulness making retrocausality not realistic.

Let's recall that earlier we made the argument that while the wave function has aspects that are clearly not ontic or real, they are some ontic components to the wave function else it would merely be metaphysics or strictly mathematical with no usefulness to physical science. This meant that due to real, ontic behavior of the wave function there must be some causal loopholes which could allow for retrocausality. In this way the argument tells us there are some aspects of the wave function which are local. However, the error in this logic is that it thinks ontic and the real in classical terms. We have already seen that advocates of retrocausality are willing to tell us that ontic and epistemic, cause and effect, cannot be reversed due to the spooky nature of quantum physics. In classical physics there should be no reason why the ontic and epistemic (expected results) could not be reversed in cause and effect. Reversibility is even fine in relativity. So, why should we exclude the possibility of oddity or exotic causal effects which are not local and/or not causal? We cannot conveniently assume one situation is exotic (ontic and epistemic) and another situation is not exotic. This is probably the biggest blow to retrocausality.

Philosophical Questions Posed by Entanglement

Matter is not 'real' in the mechanical, objective fashion history has conditioned us for but emerges from purely virtual, mathematical, informational, potential possibilities actualized as infinites of wave patterns we call quanta and discrete states. This is what classical and modernistic history called matter, reality, existence. The virtual peculiar kind of information of which I write is not subject to laws of cause and effect or space and time but creates 'laws' of cause and effect and space and time. The actualized wave function tells us, we have observed that under such and such conditions, such and such a phenomenon has a probability of occurring. Our present world,

reality, is increasingly highly dependent on the technologies which came out of quantum mechanics and the technologies which are amazingly coming out of it. It's important to understand that quantum mechanics does not in any way work like a machine.

Machines will work the same way all the time as long as they do not break down. There is a high amount of certainty about the workings of a machine. This is their utility. By necessity or essence, if you will, quantum mechanics is uncertain. Practically, this means we may have varying degrees of certainty, but quantum mechanics will never be able to be totally deterministic. In fact, determinism, otherwise called classical physics, is a very special case of indeterminism not the other way around. Effectively, this means when we think something is certain, we are only having mental gymnastics about uncertainty. Certainty comes with a whole lot of assumptions which are already baked into the cake of uncertainty not *vice versa*. We take it as normal that, essentially, reality is stable. Mechanism is not reality. It is a myth we tell ourselves. Now, I want to look at how mechanism arises in history.

Aristotle's Final Goal

A major field of study in the history of philosophy is called teleology. Teleology in ancient Greek is composed of "*telos*", the end or purpose and "*logos*", discourse, or reason. *Logos* derives from a Proto-Indo-European root, **leǵ-*, which can have the meanings "I put in order, arrange, gather, I choose, count, reckon, I say, speak." [638] Teleology is the explanation of phenomena in terms of the purpose they serve rather than of the cause by which they arise. It is the ultimate purpose, goal, or completion of some phenomenon. This was a major concern of the ancient Greeks and in particular, Aristotle.

We could say that teleology is the study of something's final purpose. Aristotle asks the question of the final goal or purpose in nature in his work called "Physics". Aristotle tells us,

There is a puzzle, what prevents nature from acting not for a purpose, nor because it is better, but in the way that Zeus rains, not in order to make the crops grow, but of necessity? For what goes up must get cold, and what has got cold becomes water and comes down. And when this takes place, the coincidental result is that the crops grow. And likewise too, if someone's crops rot on the threshing-floor, it doesn't rain for the sake of this - in order that they should rot - but this is a coincidence. So what prevents parts in nature also being like this - for example, that it should be of necessity that the teeth grow with the front ones sharp and suitable for cutting, the molars broad and useful for grinding food? For it was not for the sake of this that they came about, but it was accidental. And likewise concerning the other parts in which there seems to be purpose. So wherever everything coincides as if it had come about for a purpose, these ones were preserved, having combined in a suitable way spontaneously; while those which did not turn out thus perished, and are perishing, as Empedocles says of the ox-children man-faced. This, then, is the argument by which one might raise puzzlement, and there are others like it.

But it is impossible for things to be thus. For these things, and all natural things, come about as they do either always or for the most part, whereas none of the products of luck and spontaneity does that. For it does not seem to be from luck or accident that it rains regularly in winter, but it does if it rains in August. Nor do heatwaves in August seem to be from luck or accident, but heatwaves in winter do. If therefore it seems to be either from chance or for a purpose, and if it is impossible for these things to be either from chance or from accident, they must be for a purpose. And yet all things of this kind are natural, as even the proponents of this argument would claim. Therefore there is purpose in the things which come to be and are by nature.639

Aristotle tells us in this passage that pure chance and accident cannot give an account of nature [*phusis*]. He writes, "*Therefore there is purpose in the things which come to be and are by nature."* This idea is encapsulated in the phrase 'for the sake of which'. Just after the Enlightenment era, the mechanical revolution in the 18th and 19th century posed a new question to teleology. Can the final purpose for beings of nature be thought of in the same way as the final purpose for machines?

The Mechanics of Kant

In the 18th century Immanuel Kant tells us that the final purpose of a machine does not come from nature but from pure concepts in the creators of the machine. The purpose could not be thought of as a product of nature but more like a product of art. A product of art does not happen naturally according to Kant but from the mind of the artist. In our case, mechanics certainly implies 'machine'. From this, the question naturally arises, "What is meant by the 'mechanics' in quantum mechanics?" This is the distinction which must be pursued to decipher the difference between mechanics and the philosophical questions posed by entanglement.

From the Latin transformation of *phusis* to *naturalis* or nature, Professor Hannah Ginsborg gives us a more in-depth historic look into the inquiry of this historic assumption of 'uniqueness of purpose' and its other 'natural processes'. Aristotle further distinguishes between beings which come about through natural processes and beings which come about from a purpose. Kant criticizes this notion in his "Critique of Teleological Judgment". Kant tells us that natural processes can also retain a natural purpose. Natural processes are not blind, devoid of anything we can deem as purpose. Ginsborg writing of Kant's criticism of Aristotle tells us,

To say that something "is possible only as a purpose" is to

> say that “the causality of its origin must be sought not in the mechanism of nature, but in a cause whose capacity to operate is determined through concepts”. And in order for a thing to qualify as a purpose, “it is required . . . that its form not be possible in accordance with mere laws of nature . . . but rather that even the empirical cognition of it . . . presupposes concepts of reason”. He illustrates this with the example of a regular hexagon found drawn in the sand in an apparently uninhabited land. If we were to come upon such a shape we would rule out as its cause such factors as the sand, the sea, the wind or animal footprints. For “the contingency of coinciding with such a concept . . . would seem so infinitely great that there might just as well be no natural law for it”. We would rightly conclude that “the causality for such an effect could not be contained . . . in any cause in merely mechanically operative nature,” and would thus be entitled to view it as a purpose. But, Kant goes on, we would not be entitled to regard it as a natural purpose: rather, “it could be seen [only] as a product of art”. 640

So, Kant thinks that an example of a purely natural mechanism of nature can have purpose. However, for Kant, its cause is of itself or in itself. In the case of an organism, a natural purpose is when an organism has a cause and effect in and of itself. The purpose arises naturally, from nature. An artisan or builder of a house has a purpose, an intent which is external to the work of art or the built house. The work of art did not create itself. The house does not build itself. Ginsborg continues the discussion of Kant,

> To “judge something which we recognize as a natural product at the same time also as a purpose, and hence as a natural purpose . . . more is required”. This leads him to what he calls a provisional statement of what is required for something to qualify as a natural purpose: it must, he says it

must be “cause and effect of itself”. He illustrates this with an example, describing three important ways in which a tree is cause and effect of itself. First, a tree both can generate, and is generated by, another tree of the same species, so that the species maintains itself. Second, a tree produces itself through its own growth and development, processing and shaping the organic matter which is added to it in the course of its life. Third, the different parts of the tree depend on one another for their continued existence: the leaves cannot subsist without nourishment from the trunk, which in turn depends on the leaves for its growth.[641]

Kant’s Frankenstein Machine

Ginsborg writing of Peter McLaughlin tells us that mechanics implies that parts of a machine have an independence from the whole, the machine. A thing resists mechanics if the parts have a relationship to the whole that they would not have had by themselves as McLaughlin thinks would be the case for an organism.

> …a mechanical explanation means the reduction of a whole to the properties (faculties and forces) which the parts have ‘on their own’, that is independently of the whole”. A thing resists mechanical explanation if “the parts can have properties in the whole and due to their presence in the whole which they would not (did not) have independently of their existence in the whole”. This is not the case for a machine, whose parts “have precisely those properties in the machine that they had before they were put together to make the machine and . . . [which] do not lose any properties when the machine is taken apart.” For example, “[r]igid gears and levers do not become elastic in the machine and springs and transmission belts do not become rigid. But it

> does appear to be the case for organisms, since, as McLaughlin puts it elsewhere, organisms seem to manifest "a causal relation in which the whole acts on the properties of the parts". The implication, then, is that organisms are mechanically inexplicable in virtue of their non-machine-like character. 642

However, what we mean by quantum mechanics seems entirely different from any of these notions of mechanics. For quantum mechanics, parts are not separate things but exformation. Furthermore, this information given as the quantum wave function collapse is empirical in the sense of statistically verified, experimental observation. By 'exformation' I mean there is no prior intentional cause effecting quanta to pop in and out of existence as if spacetime was intentionally bound to a god-like created, metaphysical 'there' or 'temporality'. In the case of informational, 'experimental observation' is purely contingent on a *phusis* of non-intentionality, non-existence, or no-thing. Any contrived purpose would have to be fundamentally uncertain. By 'uncertain' we do not mean because we have not found the 'true' hidden certainty because, for example, we do not have more advanced instruments or computers to ascertain the hidden, underlying certainty. The 20th century proved that the idea of certainty built into classical physics does not exist for quanta. We will explore more of this later.

Ginsborg ends his argument with this,

> What natural selection does undermine, by contrast, is the argument that the presence of plants and animals requires a divine artificer. For it allows us to see how organisms could arise through natural processes, and hence qualify—in spite of their teleological character—as products of nature. That aspect of Kant's and Aristotle's view was challenged, I just suggested, by the achievements of molecular biology, which encourage us to regard organisms on the model of highly

> complex artifacts. But the theory that life originated through natural selection offers a response to that challenge by showing how these artifact-like structures could have arisen without the intervention of a conscious agent. Admittedly the conception of "natural" here is very different from the conception which Aristotle and Kant would have accepted. For, as I pointed out a moment ago, the kind of natural production hypothesized by the theory of natural selection allows a central role to chance: and chance is excluded from both Aristotle's and Kant's conception of nature. But despite that caveat, we can still see the selectionist account as playing something of the same kind of role for us that the non-machine-like character of organisms plays for Aristotle and Kant. Like the non-machine-like character of organisms, it enables us to avoid a Platonic conception of organic form as supernaturally imposed on independently existing matter. Yet it does not enable us, any more than the non-machine-like view of organisms, to dispense with teleology.[643]

Teleology's Limiting Case

The tension to 'dispense with teleology' seems to me to be the same suspense we face when quantum mechanics must dispense with classical physics. There certainly is a context in which classic physics shows up as a limiting case of quantum mechanics. However, 'limiting case' here means 'given certain assumptions' which imply that these 'assumptions' have a veneer of acceptability but upon deeper inspection have an air of artificiality. We have the same circumstance with teleology. There are notions in historic teleology which intuit self-cause or 'cause and effect of itself' such as the Kantian thing in itself but their applications with regard to phenomena were strained by logical conclusions which were forced from constraints based on their temporal settings of language and culture. Even natural selection has been forced in recent times to

deal with chance as Ginsborg points out or better emergence. With regard to the question of chance in natural selection, the question remains whether ‘chance’ in this case is yet constrained by teleology. Emergence in natural selection has more of a sense of post-hoc, historic observation from a kind of uncertainty which has no roots in the trappings of classicism. What is the persistence of what we think of as ‘reality’.

For example, we think that when we die, reality will go on as we always assumed it would. However, how we think ‘reality’ is, is bracketed by a particular moment and place of time in the history of reality, e.g., of the universe. Actually, what we think is ‘reality’ is a vanishing, infinitesimal, circumstance of our ‘assumption’ of reality. This infinitesimal moment of reality was never based on absolute certainty as Descartes thought when he stated “cogito, ergo sum” (Latin: “I think, therefore I am) in his Discourse on Method. Even ‘absolute’ in the context of quantum uncertainty may be an artifact of idea. Specifically, at least in the case where ‘absolute’ is thought in terms of some kind of epistemological certainty.

> The term “epistemology” comes from the Greek words “episteme” and “logos”. “Episteme” can be translated as “knowledge” or “understanding” or “acquaintance”, while “logos” can be translated as “account” or “argument” or “reason”.[644]

How we know that we know has been an important part of philosophy and science. In the next section I want to give some background on epistemology and how Leibniz is still thought of as having had intuitive contributions to quantum physics.

Newton, Leibniz, Descartes, Kant, Spinoza

Gottfried Wilhelm Leibniz (1646-1716) posed questions which have been argued to this day. Namely, the idea of uniqueness and

identity. Plato found identity in the Forms. Aristotle found uniqueness in the unmoved mover. Moreover, Aristotle recognized differences in species but within a particular species differences were accidental. Leibniz found the idea of identity with anything other than itself was impossible. Monads are self-identical but absolutely different, non-identical from anything else. Monads are not caused, nor do they interact with anything outside of themselves.[645] Materialism does not exist for Leibniz. Perception as 'mine' is absolutely unique. Leibniz tells us that perception cannot be explained with a mechanical metaphor.

> One is obliged to admit that perception and what depends upon it is inexplicable on mechanical principles, that is, by figures and motions. In imagining that there is a machine whose construction would enable it to think, to sense, and to have perception, one could conceive it enlarged while retaining the same proportions, so that one could enter into it, just like into a windmill. Supposing this, one should, when visiting within it, find only parts pushing one another, and never anything by which to explain a perception. Thus it is in the simple substance, and not in the composite or in the machine, that one must look for perception.[646]

The simple substance for Leibniz was the monad. Below is Leibniz' argument for why no-thing can be identical with any other thing. Leibniz is known for three great metaphysical principles:[647]

1. The Principle of Noncontradiction (Aristotle)
    a. contradictory propositions cannot both be true in the same sense at the same time
    b. p is the case and p is not the case are mutually exclusive
2. The Principle of Sufficient Reason

a. for every fact f, there must be a sufficient reason why f is the case
b. for every x, there is a y such that y is the sufficient reason for x.

3. The Indiscernibility of Identities (Leibniz' Law)

a. if two entities are identical with each other then they have the same properties
b. for any x and y, if x is identical to y, then x and y have all the same properties [648]

The law of noncontradiction has already been discussed with regard to Aristotle. However, for Leibniz and Immanuel Kant (1724-1804), the law of noncontradiction defined the difference between analytic and synthetic propositions. Analytic propositions are true or false strictly in terms of their meaning. Synthetic propositions may be true or false depending on how they relate to the world. For Leibniz analytic statements follow from the law of noncontradiction and synthetic statements are based on the Principle of Sufficient Reason.[649] For Kant, an analytic proposition is when the predicate proposition is contained in the subject proposition and a synthetic proposition is when the predicate proposition is not contained in the subject proposition but still maintains a relationship with the subject proposition.[650]

There are many variations of the Principle of Sufficient Reason. The Principle of Sufficient Reason can tell us there is a reason for every fact. In other words, there are no brute facts which are unexplainable. This does not mean that the reason has to pass some sort of logic test to be true. It only means that any statement has a context which suffices as a 'sufficient reason'. Actually, the Principle of Sufficient Reason is a family of principles which apply restrictions to the principle. These restrictions recognize various degrees of strength in different categories of reason. The restrictions also maintain that not all things even require reason. The Principle

of Sufficient Reason need not apply to actual entities (ontic as existent, real, being, etc.) but may also apply to potential entities as well (metaphysical, nonexistent, ideal, etc.). One variant of the Principle of Sufficient Reason might require an explanation for the existence and non-existence of things. Some versions of the Principle of Sufficient Reason apply to contingent and necessary propositions or only apply to one or the other. The Principle of Sufficient Reason can apply to our world or all possible worlds.[651]

So, what do we mean by the word 'same'?

The same can mean absolutely identical. In this case identity is the relation that anything has with itself, or we could say it is purely self-relational.

Or the same could mean qualitative the same in particular ways. This is not identical but contingent or conditioned by qualities. If two objects have all their properties in common, they are considered indiscernible from each other. But this is impossible for Leibniz.

There has been and still is much debated on exactly what Leibniz meant when he distinguished the difference between indiscernibility and identity. Below are two versions of how Leibniz distinguished between two different ideas of identity:

The Indiscernibility of Identicals [652]

The principle of Indiscernibility of Identicals is uncontroversial and states that if two entities are identical with each other then they have the same properties. Note that this states two entities or objects. This is not inclusive of self-identity.

Here we start logically from the abstract notion of identity to concrete, empirical properties in the real world. So, to go from an abstract definition to real objects in the world requires that the real objects conform to the logical principle to be true or false, to be identical, to have the same properties. But this is impossible and absurd for Leibniz as only self-identity can be valid.

Therefore, the notion of identity is abstract and formal for objects in any sense – this world, other worlds, or nonexistent

worlds. A logical statement of identity is not based on anything real. It is purely abstract such as A = A or 1 + 1 = 2. A logical statement is true or false on its own. It is simply based on a definition. It has nothing to do with ontology, existence, reality, beings, etc. This is where Leibniz' idea of monads comes into play. By definition monads are always and only identical with themselves. This is why Leibniz thought that logic dictates there must be something like monads which contain absolutely and infinitely everything as only a monad could be identical with itself. However, no two monads are ever identical with each other. If the real world is a machine made up of parts, separate things, it can never explain perception. Perception is mind which is self-identical as monad. Materiality does not exist except in mind, perception, monadology. Only one simple thing can explain perception, a monad, which is infinite and absolutely self-contained with no exteriority to itself.

The identity of indiscernibles 653

The principle of identity of indiscernibles, on the other hand, is more controversial in making the converse claim that if two entities have the same properties then they must be identical.

It starts from ontology, things, entities, objects in the real world and tells us that any two objects can never be identical because if nothing else, they are separate objects in space and/or time.654 This principle can never be true in the real world or any imagined world. This is a metaphysical principle in that no two things can ever be identical. To go from objects in the world to the abstract principle of identity means that any two objects in the real world, like two leaves, would have to be the same thing. However, because they are not the same thing that would be a difference which makes identity impossible. So, two leaves or two different 'anythings' could not be said to be identical.655

Leibniz further tells us,

Furthermore, by means of the soul or form, there is a true

unity which corresponds to what is called the I in us; such a thing could not occur in artificial machines, nor in the simple mass of matter, however organized it may be.

But in addition to the general principles which establish the monads of which compound things are merely the results, internal experience refutes the Epicurean [i.e. materialist] doctrine. This experience is the consciousness which is in us of this I which apperceives things which occur in the body. This perception cannot be explained by figures and movements.[656]

Rene Descartes (1596-1650) argued in *Principia philosophiae* (1644) for an absolute quantity of motion. Leibniz disagreed based on his idea of the "living force". As Leibniz was a cofounder of calculus, he described the living forces as,

$$\sum_i m_i v_i^2$$

[657]

This means for all 'i's made up of 'i' masses, the sum of all the masses times its velocity squared is conserved. Leibniz called this quantity *vis viva* or 'living force'. This formula actually represents the conservation of kinetic energy in elastic collisions and was independent of the conservation of momentum.

However, Descartes and Newton formulated their idea of the conservation of momentum as,

$$\sum_i m_i \mathbf{v}_i$$

658

This means for all ‘i’s made up of ‘i’ masses, momentum was conserved given by the sum of all masses times the velocity of the mass.

After 1807 *vis viva* began to be known as the conservation of kinetic energy. However, over the years 1819 through 1839 Gaspard-Gustave Coriolis and Jean-Victor Poncelet revised Leibniz’ conservation of kinetic energy to,

$$E = \frac{1}{2} \sum_i m_i v_i^2$$

659

In Isaac Newton’s (1643-1727) absolute reality everything was ordered by God. In this way, God was the abstract identity, the formal logic which all ontology, all reality, all time and space, all existence was based on. Newton claimed that space and time were absolute,

> Newton, and after him Clarke, argued that space and time must be absolute (that is, fixed background constants) and in some sense really existent substances in their own right (at least, this was Leibniz’s reading of Newton).660

The reason things seemed to be contingent was not due to God but to our inability to know all the laws of God. However, Leibniz

deemed Newton's ideas as unable to explain anything in the real world or even an imaginary world. Leibniz found Newton's theories ludicrous.

Leibniz made quite a stir when he questioned Newton's assumptions. Remember that Leibniz had this notion of monads. Monads were hidden, an unmanifested reality. Therefore, a sufficient reason need not be absolute. A sufficient reason might be purely contingent, even hidden from us. For Leibniz instead of basing everything on absolute laws of nature and God he believed that reason was not absolute but contingent.

> Leibniz's most famous arguments for his theory of space and time stem from the principle of sufficient reason (the principle that everything which happens has, at least in principle, an explanation of why it happened as it did and not otherwise). From this principle, together with the law of non-contradiction, Leibniz believes that there follows a third: the principle of the identity of indiscernibles, which states that any entities which are indiscernible with respect to their properties are identical. Leibniz is fond of using leaves as an example. Two leaves often look absolutely identical. But, Leibniz argues, if "two" things are alike in every respect, then they are the same object, and not two things at all. So, it must be the case that no two leaves are ever exactly alike.
>
> Leibniz's support for the principles of the identity of indiscernibles primarily derives from his commitment to the principle of sufficient reason in the following way. If any objects are in every way the same, but actually distinct, then there would be no sufficient reason (that is, no possible explanation) for why the first is where (and when) it is, and the second is where (and when) it is, and not the other way around. If, then, one posits the possible existence of two identical things (things that differ in number only–that is, one can count them, but that is all), then one also posits the

> existence of an absurd universe, one in which the principle of sufficient reason is not universally true. Leibniz often expresses this in terms of God: if two things were identical, there would be no sufficient reason for God to choose to put one in the first place and the other in the second place. (Note that Leibniz's argument relates to a scholastic debate centered on the notion of "Buridan's Ass.")[661]

For Newton, God and the universe were absolute. Matter, space, and time were dead for Newton. For Newton, the universe was dead. Newton believed that the universe had set laws which were not contingent but based on the laws of God. For Newton, the job of science was to discover these absolute laws which regulated the universe, God's creation. Leibniz argued that matter was alive and held within it a "living force" for charge. Leibniz thought that Newton's absolute space and time was absurd. Leibniz argued that if space were absolute, one could not discern any region of space from any other region of space. But if that were true the only way to explain different locations in space would be extrinsically or added in from somewhere else. Also, if space were absolute why wouldn't the whole universe be created two meters to the left? Continuing from the previous quote,

> Similar considerations apply to Newtonian absolute space. Leibniz's argument against the Newton-Clarke position can be understood here as two related reductio ad absurdum arguments. The first concerns the violation of the principle of the identity of indiscernibles. Suppose that space is absolute. Since every region of space would be indiscernible from any other and spatial relations would be construed as extrinsic, it would be possible for two substances to be indiscernible yet distinct in virtue of being in different locations. But this is absurd, Leibniz argues, because it violates the principle of the identity of indiscernibles. Therefore, space must not be

> absolute (see “Correspondence with Clarke,” Leibniz’s Third Paper). The second reductio concerns the violation of the principle of sufficient reason. Suppose that space is absolute. Leibniz argues that there would then be no sufficient reason for why the whole universe was created here instead of two meters to the left (because no region of space is discernible from any other). Thus, absolute space is absurd, because it violates the principle of sufficient reason (see “Correspondence with Clarke,” Leibniz’s Fourth Paper). (Analogous problems are thought to result from a conception of absolute time.)[662]

Baruch Spinoza (1632-1677) thought of the Principle of Sufficient Reason as nothing exists which cannot be asked, ‘what is the cause or reason and why it exists’? Axiom 7 in the quote below means out of nothing, nothing comes.

> Since existing is something positive, we cannot say that it has nothing as its cause (by Axiom 7). Therefore, we must assign some positive cause, or reason, why [a thing] exists—either an external one, i.e., one outside the thing itself, or an internal one, one comprehended in the nature and definition of the existing thing itself.[663]

However, there is one exception to the quote above when Spinoza writes, “*[T]hat Thought is also called true which involves objectively the essence of some principle that does not have a cause, and is known through itself and in itself*.”[664] It is interesting that Spinoza makes this exception as I have also referred to entangled quantum information as uncaused and without origin. Spinoza also tells us that, “*From a given determinate cause the effect follows necessarily; and conversely, if there is no determinate cause, it is impossible for an effect to follow*.”[665] As I have discussed entangled quantum information is chaotic, in superposition until varying degrees of wave function

collapse or information branching assigns observationally probabilistic ordering, cause and effect. This is echoed from the previous article cited the author who tells us for Spinoza,

> Each link in this causal chain is preceded by infinitely many causes and is followed by infinitely many effects. Each link also provides at least part of the explanation for the existence of the following link. Is the existence of such an infinite regress consistent with the PSR? Spinoza has no qualms about answering this question in the positive. We may legitimately ask what is the cause of each link in the chain, and the answer would be: the preceding link. Spinoza also thinks that we may—indeed, should—ask what is the cause, or reason, for the existence of the entire infinite chain? He simply thinks that he can provide a clear answer to the latter question as well: God (or the being which is the ground of its own existence.)[666]

Leibniz has been the subject of a number of authors who find astounding intuitions he had of quantum physics. In the quote above this could almost have been written by Everett concerning branching worlds in the information updates of wave function collapse with the inclusion of the observer effect. In Leibniz' major work entitled Monadology Gottfried Cooperman finds room to accommodate a quantum theory of gravity. We can see from Leibniz' "living force" of matter and unmanifest reality a relation with actuality and potentiality and a spooky kind of interaction between the two. By 'living force' Newton harkens back to perception and monads. Could this have been an intuition of the observer effect in the quantum wave function? Leibniz can and does accommodate possible worlds. We also see that if there is no reason for one thing to happen over another, the Principle of Sufficient Reason, nothing happens – superposition. Since Leibniz did not accept materialism, mechanics, of his day as viable, Leibniz'

metaphysical idea of space and time as built on 'living force' might agree with quantum physics idea of non-locality. Leibniz refers to monads as simple and infinite with no parts, but they could take on qualities, if necessary, for the situation reminding us of wave-particle duality and complementarity. Monads are uncaused, without origin.[667]

As mentioned, Leibniz investigated the problem of identity. Leibniz formulated the "Principle of Identities of Indiscernibles" which stated that if two objects have all the same properties, they are indiscernible and therefore, identical. Leibniz found this to be an impossible supposition. Quantum entanglement has prompted much discussion among philosophers as to whether or not entanglement can be considered a case of self-identity.[668] Why is this important? Because Western history and particularly the metaphysics of individuality are bedrock assumptions, especially in the United States. The metaphysic of individuality rests on the principle of self-identity. More broadly, first order logic, deductive reasoning where the predicate is contained in the subject is intimately related to the notion of identity and tautology. Tautology is a statement that is necessarily true by virtue of its logical form. In logic A = A is a tautology of self-identity. Anything, object, or entity designated as something must be equal to itself. This is why Leibniz' Principle of Noncontradiction, Sufficient Reason, and Indiscernibility of Identities is pivotal in the history of philosophy, logic, and metaphysics. Let's dig into why identity is critical to Western history.

Identity and Entanglement

The notion of self-identity is a basic tenet of a school of thought called realism. An ardent advocate of realism in analytic philosophy was Willard Van Orman Quine[669]. Quine's slogan tells us 'no entity without identity'. His famous dictum tells us 'to be' is to be the value of a variable'.[670] This statement reflects the property of

substitution. Realism finds its truth value based on first-order logic whose properties are relational, substitutional, and identical. Self-identity cannot be denied without being a contradiction. That is prior to problems posed by quantum entanglement.

First-order logic includes quantifiers which include predicates about inclusion in sets. For example, we could state that “there exists x such that x is Socrates and x is a man", where "there exists" is a quantifier of a set, while x is a variable. By ‘quantifier’ what is meant is a relation or a qualifier. If identity rests on quantified properties of sets of properties that are indiscernible, how would that apply to quantum entanglement? Entanglement certainly has apparently identical properties but ‘identical properties’ are problematic for entanglement. This is due to the fact that entanglement is conditioned by observation and shakes the very foundation of any such thing as objective realism. To think of properties which are conditioned by observation, not bound by cause and effect in spacetime, puts into question the whole classical notion of ‘existence’ and ‘objectivity’. What could it mean to think of properties as existent dependent on observation and not bound by causal relations? And what could it mean to think that these properties do not exist in the state of superposition except when observed and the wave function collapses?

Quantum entanglement happens all the time, not just for the laboratory condition where we have two particles. Anything and everything that ‘is’ has entangled particles. This means a tree, a star, a human brain, any cogent entity, or body is a system of entangled particles. Even the emptiness and non-locality of outer space is not a vacuum at all but thought to be held together by a mesh of entangled particles. Every system has unbound particles which are not entangled at all and entangled particles. Quantum systems are continually transforming coherently into other quantum systems. Every transformation causes new entanglements, new unbound particles, and decoherence. When we are alive our biology is constantly changing creating new entangled particles, non-locally

or without regard to the relativity of spacetime and causality, and unbound particles. The process of aging is the transformation of our quantum system undergoing entropy.

In the previous section entitled ‘Entangled Systems’ I discussed how entangled systems no longer ‘are’ as a sum of particles but lose their individual particle-like ‘self-identity’ to act like a coherent entangled entity. The coherent entangled system, a uniform entity, no longer exists as individual particles and properties. The coherent entangled system no longer exists as a summation of individual parts. This is the idea of a flock of birds used to illustrate separate particles which are transformed in coherent entangled behavior to become one coherent bird with regard to specific properties like spin for example.

> Another feature of quantum states is that they can be correlated with other quantum states, meaning that measurements of one state can affect the other. In a 1935 paper, Albert Einstein, Boris Podolsky and Nathan Rosen examined how strongly correlated quantum states would interact with each other. They found that when two particles are strongly correlated, they lose their individual quantum states and instead share a single, unified state. Another way to think about it is that a single mathematical "container" can describe all particles simultaneously, regardless of their individual properties. This unified state would become known as quantum entanglement.[671]

By entangled particles of systems losing their individual quantum states and instead sharing a single, unified state, a single mathematical container, we have encountered problems which history and Leibniz could never have imagined.

The next quote below is a discussion of different ideas on how identity and individuality (or Leibniz’ separate entities) can be understood in light of a ‘flock of birds becoming one, unified bird’.

One position might be that we could call this entangled system behavior non-individuality, not identity. This is the case of one bird where the flock of birds no longer exist. Some have thought of this in terms of the denial of self-identity where the flock of birds no longer exist due to the transformation as self-identical, entangled whole entity (perhaps Leibniz' monad). [Note: there are references to studies in the referenced link I have omitted for clarity.]

> Alternatively, but relatedly, non-individuality can be understood in terms of the denial of self-identity. This suggestion can be found most prominently in the philosophical reflections of Born, Schrödinger, Hesse and Post. It is immediately and clearly problematic, however: **how can we have objects that are not identical to themselves? Such self-identity seems bound up with the very notion of objecthood in the sense that it is an essential part of what it is to be that object (thus it has been suggested that non-individuality might be better understood in terms of the loss of [s]patio-temporal trajectories in quantum physics**. This intuition is summed up in the Quinean slogan, 'no entity without identity', with all its attendant consequences regarding reference etc. 672

This brings on another perspective from the denial of self-identity when it comes to entangled systems. This is due to the problem of thinking exclusively that all objects can be reduced to objects or things. In a more technical way, I understand the quote bringing out two kinds of objects: standard thing-like objects and quantum-like objects. Quasi-set theory posits everyday thing-like objects and also quantal (quantum-like) objects. The quote illustrates how academic, "*philosophically respectable"* hurdles might be overcome to maintain a weak type of discernability (Leibniz). The quote below ends with a conclusion that the notion of non-individuality of quantum systems might be overcome as simply a

semantic difference not a metaphysical difference. In other words, the entangled body might not be something different, above classical physics or metaphysics, but simply a way of talking about two types of objects (in Leibniz' sense). In the author's opinion this would open up a more pragmatic way of thinking about entangled quantum systems.

> However, Barcan Marcus has offered an alternative perspective, insisting on 'No identity without entity.' and arguing that although '… all terms may "refer" to objects… not all objects are things, where a thing is at least that about which it is appropriate to assert the identity relation.' Object-reference then becomes a wider notion than thing-reference. Within such a framework, we can then begin to get a formal grip on the notion of objects which are not self-identical through so-called 'Schrödinger logics', introduced by da Costa. These are many-sorted logics in which the expression $x = y$ is not a well-formed formula in general; it is where x and y are one sort of term, but not for the other sort corresponding to quantum objects. A semantics for such logics can be given in terms of 'quasi-sets'. The motivation behind such developments is the idea that collections of quantum objects cannot be considered as sets in the usual Cantorian sense of '… collections into a whole of definite, distinct objects of our intuition or of our thought.'. Quasi-set theory incorporates two kinds of basic posits or 'Urelemente': m-atoms, whose intended interpretation are the quantal objects and M-atoms, which stand for the 'everyday' objects, and which fall within the remit of classical set theory with Ur-elements. Quasi-sets are then the collections obtained by applying the usual Zermelo-Fraenkel framework plus Ur-element ZFU-like axioms to a basic domain composed of m-atoms, M-atoms and aggregates of them.
>
> These developments supply the beginnings of a categorial

framework for quantum 'non- individuality' which, it is claimed, helps to articulate this notion and, bluntly, make it philosophically respectable. Crucially, within this formal framework, a sense of countability is retained in that collections of quantum entities possess a (kind of) cardinality but not an ordinality, so we can, in effect, say how many objects there are, even though we cannot place them in numerical order. Critical discussions of both these formal details and of the basis for attributing 'non-individuality' to quantum objects can be found in Bueno et. al. and Sant' Anna. Much of this criticism has proceeded on the basis of insisting that we do not need to adopt such an apparently radical approach. Thus advocates of 'weak discernibility', discussed above, have argued that this notion yields an appropriately naturalist sense of individuality, suitable for quantum physics, whereas Dorato and Morganti insist, as already noted, that one can retain countability, and individuality, as primitive notions and that this is to be preferred over any shift to non-individuality. Jantzen on the other hand, has argued that identity and cardinality are tied together as a 'matter of meaning' rather than metaphysics and that, consequently, talk of entities without identity is either meaningless or, in fact, talk about something else altogether. Likewise Bueno has insisted that identity is too fundamental to be given up so readily and suggests that we can infer the non-individuality of quantum particles directly from their indistinguishability with identity itself understood as a 'useful idealization' that simplifies our conceptual framework and allows us to predict the behaviour of the relevant objects – in this case quantal entities.

Both the framework of quasi-set theory and the underlying metaphysics have been extended into the foundations of Quantum Field Theory, where it has been argued, one has non-individual 'quanta'. A form of quasi-set

> theory may provide one way of formally capturing this notion. It has also been suggested that this offers a way of understanding the sense in which quantum objects may be regarded as vague, although it has been questioned whether vagueness is the appropriate notion here and also whether quasi-set theory offers the most perspicuous way of capturing this sense. Finally, for those who are leery of quasi-sets and their attendant formal apparatus, there is also the option of returning to Weyl's original insight, which underpins the quote above, and appropriating his idea of an 'aggregate'. If this is interpreted non-set-theoretically as an equivalence relation, where the relevant elements are understood as simply objects that have certain properties in common, one can continue to maintain that such objects do not have well-defined identity conditions. Indeed, there may be a variety of such frameworks, both formal and metaphysical, in terms of which non-individuality may be understood.[673]

In the discussion above identity and some strange, spooky other which does not fit classical notions of reality is the brunt of the inability to provide acceptable categories that make sense out of quanta and entanglement as "*the characteristic trait of quantum mechanics*". Since I am not an academic, I can write freely. Coherent entangled systems seem to me exactly what Leibniz had in mind when he talked about monads. Coherent entangled systems then would be self-identical-like not as a collection of mechanical parts but as a coherent, perceptive body Leibniz calls a monad. However, the difference from a monad is the coherent entangled system has the spooky factor. A monad does not have materiality so it can be fully based in perception, the observer effect. Remember that the observer is part of the entangled system. So, the observer is 'the flock of birds which disappear into the unified bird' or the coherent entangled system. So, perception can unify as the collapse of superposition, informational branching of the wave function. This

coherent entangled system entity is not a collection of lower entities in the traditional machine-like sense but more like an entity which comes into existence from what church history might have called 'creation out of nothing' or *creatio ex nihilo*. Leibniz could simply think of this as perception. However, as I think that our language, history, and entrenched forms of thinking offer no convenient off-ramp, I simply call it spooky. I think Leibniz would have called it monadic self-identity but with the distinction that it is not metaphysical or physical in any traditional way of thinking.

What complicates all this more is, all coherent entangled systems are becoming into existence and out of existence, decoherent and re-cohering with other entangled systems like froth and foam on ocean waves – all in the context of superposition and wave function collapse. However, all this seems to even make the use of the word 'entity' or 'object' obsolete. This awkwardness of thought and language shows the chasm which finds no other side. In terms of our lived experience, what shows itself is not provided by narratives of the past but asks us to let go of our helpless grappling and simply be with our chaotic loss of origin (and therefore path forward) to see what other alterities might wait us.

Entropy and Information

Entropy comes from the ancient Greek word *entropia* meaning "a turning toward" or transformation. Entropy is hidden information or information which has been lost. This means the information cannot be directly accessed in terms of work or usefulness. But work can still be useful even in its loss of information by differences in systems which have lost varying amounts of information. For example, the cylinder in a car ignites which produces a burst of highly disorganized information relative to the gasoline vapor. This difference in information between the confines of the cylinder and the ignition of gas vapors, explosive increases in entropy can be converted to mechanical rotation of the cylinder to produce

propulsion or work as any car engine demonstrates. Quantum systems undergo quantum entropy, information which is no longer accessible to the observer. But quantum entropy has no physical properties like heat, thermodynamics, energy, etc. Quantum entropy is a result of entangled systems in the wave function of which we have no information about. It is a measure of our ignorance of systems in the wave function due to entanglement. Classically, our body starts 'falling apart' which means certain information about bodily functions are no longer as useful to us - it is increasingly information which has been lost or broken down of our embodiment. Another way to think about entropy is as thermal equilibrium. Thermal equilibrium is the essential tendency for all classical system's temperature to equal their ambient environment. Temperature is related to the ratio of heat and entropy. All entropic transformations (transformations of entropy) in the universe happen regardless of situatedness, birth, life, and death. Entropy is a quantifiable process of mutating transformations which have no categorical distinctions in terms of birth, life, or death, anything, and everything existent. Entropy is a measure of chaotic information in a system and as such can give us an idea of how much useful information may be in a system. As chaotic, hidden information can only increase or stay the same over time, some physicists liken it to the arrow of time. In other words, entropy is the proof that the way we experience time has some basis in actual physics.

The Heat Death of the Universe

It is interesting to note that the 'heat death of the universe' will end as an 'asymptotic impossibility' that is, useful energy and the impossibility of increasing entropy beyond a limit very close to absolute zero kelvin but never reaching absolute zero kelvin. This is due to quantum jitter and random activity will still have an extremely low level of energy but so small that entropy will be

essentially nothing meaning no useful information can be obtained at that point. Just like zero-point energy or vacuum energy, it is believed that quantum jitter and random energy will find an equilibrium where it will simply cancel itself out.

> Following the increase of entropy, the dissipation of matter and energy goes on until our universe becomes so infinitely disordered that entropy can no longer increase and events come to an end.
>
> This is called the heat death of the universe.[674]

Let's take note of what is meant by 'asymptotic impossibility' meaning the heat death of the universe as entropy will end so the universe will approach the limit of absolute zero kelvin but never get there. I want to make a technical comment about the above quote, I believe a better word for 'disordered' here is chaotic indicating that the normal 'laws' of order and disorder, cause and effect, have been abolished in the heat death of the universe. As chaotic and random quantum jitter and random energy, in the heat death of the universe and in zero-point energy, there will still be the quantum wave function's exformation which does not know anything about physical conditions like heat, thermodynamics, and energy. As we will see, temperatures very close to absolute zero kelvin prolong entanglement. The timeless and spaceless state of superposition is just as applicable for zero-point energy, the chaotic fabric of vacuum space as it is for everything else. Since entanglement is not local, it is not spatial in the way classicism thinks of space, we are not talking about a huge expanse of nothingness which is what the logic of our history would tell us. In the full extent of superposition where all spacetime is lost to chaos, temporality and spatiality never 'was', had 'being', had existence which only comes in the state reduction to classicism from the observer effect. So spacetime is not eternal, absolute, reality as we tend to think of it classically.

Moreover, a purely hypothetical question, could this translate to the fact that the 'heat death of the universe' might end as it began and always was? The Big Bang singularity was never 'real'. It was simply the quantum wave function. The wave function never saw what we think of as cosmology unfolding into spacetime. Existence comes from the observer effect. That does not necessarily imply that an observer like God created the universe by observing it. For the wave function the observer effect is not the temporal unfolding of branches. Perhaps one way to conceptualize it is that every observation recreates the entire classical branch. The observer effect in some very strange fashion is not merely subject or merely objective. It does not rest easily in all our categories of understanding. The branching as our universe comes into existence. into classicism in wholes not piecemeal. In somewhat constrained ways of thinking that might mean multiplicities of emergences, branching, translating us as classicism's spacetime narratives was, is, and ever will be the simultaneity of the wave function. We observe the temporalization given by the direction of time from entropy, but the wave function remains unassembled, purely chaotic information. Think about it like the Big Bang singularity did not happen 13.787 ± 0.020 billion years ago but is happening simultaneously in and through all our lived narratives.

From classical branching from the quantum wave function, we think of ourselves as existing long after the Big Bang singularity. But just as the Scientific American article entitled, "How the Inside of a Black Hole Is Secretly on the Outside" [675] describes, if we were in a blackhole we could just as well think of ourselves in the same way, as existing long after the Big Bang singularity. But we would be in the Big Bang singularity imagining all this. We have the 'sense' that we are on the outside of the singularity, but quantum physics tells us we may well still be inside the singularity. That would go a long way in explaining exformation. If spacetime is

emergent from exformation then the idea of existence permeated with entangled systems and wormholes as singularities is no longer 'out there' but in here.

I am going to introduce an idea here that I hope to make more explicit through the rest of this book. I want to give a thought-analogy to orient us away from more accessible conventional ways of thinking about space and time. I think it is important to note that this idea is not meant as some kind of mystic or psychic oracle, but only as an aid for comprehension of some implications to our commonsense notions of space and time. There is a sense at times in which classicism forces us towards a more contrived and historic semblance of what 'reality' is and what it isn't in a strained effort to validate our historic narratives. Because of the momentum of these narratives, hints of space and time from quantum physics can feel a bit awkward and as if we are in some sense suspended over a gaping void. But that feeling may have some helpful effects if we just relax and go with it for a moment.

It turns out that our more comfortable thinking,

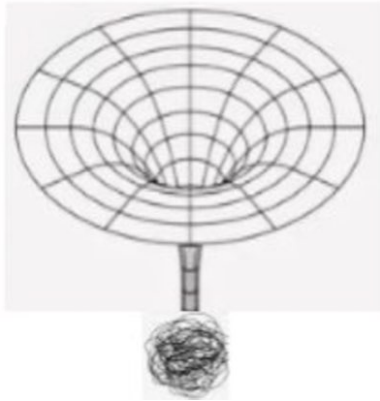
Big Bang = origin = > universe becomes = > Heat death of the universe = death, end, or culmination in the Greek sense of *telos,*

might be much more of a cumbersome and awkward kind of Rube Goldberg way to piece together space and time. Another way to think about this, which is more straightforward in a sense, is that the quantum wave function never *saw* our contraption of Big Bang-origin, spacetime-becomings-heat death-*telos*- Being-existence- etc. and we never saw the wave function's chaos of "Everything Everywhere All at Once". Perhaps the wave function had always already accounted for all the narratives we feel compelled towards in our sense of '*having subsequently spun through our branches into classicism with the observer effect which must be objective and real*'. But the observer effect exceeds pure subjectivity and classical determinism as we fall together as 'me' and 'us' in which both our collective and personal histories have situated us as *existing in reality*. What if our sense of us, as outside of the Big Bang, and our

13.787 ± 0.020 billion years after the Big Bang, and our projection towards the future heat death of the universe are *really* still on the inside of the Big Bang singularity? What if the way the wave function shows itself to us in every waking recollection of 'me here now' is still simultaneously caught up in what we think of as the ancient singularity of the Big Bang? This would imply that the Big Bang is still *occurring* as "Everything Everywhere All at Once". Might this be the quantum wave function we have been discussing? And it seems that perhaps the reasoning of the Scientific American article cited about might not be so wacky. Ok, it seems that something about cognition requires us to think the way we must, sequentially as temporality and 'heres' and 'theres' as spatiality. But if the wave function could 'see' which is absurd unless you believe in the mythical La Place demon, it would 'see' that every place is the same place and every time is the same time or better, just ignore all those mental gymnastics and simply exceed such parochial notions.

Gravity is not strictly a force as has been mentioned since it does not act locally and in similar ways independent of spatiality. Gravity as has been mentioned is due to the geometry of space. Quantum wavicles as waves are not point particles but geometric fields. Therefore, spacetime curvature is believed to be curved by quanta called gravitons. Quantum gravity has been around for decades and continues to get more and more research. This is what the next major section will discuss.

QUANTUM GRAVITY



Chaotic Quantum Wave Function Branching into Quanta Reshaping Spacetime Geometry [676]

The idea called quantum gravity has been taking physics by storm for decades. Quantum gravity is not some kind of small laboratory study of an esoteric, odd phenomenon. Many physicists believe this is finally how the very large, gravity, and the very small, quantum physics, will get reconciled. This could well be the 'relativity' of our day. Initially, after Einstein first published the special theory of relativity in 1905, relativity was perhaps unnecessarily complex. Over the years it has become less complex.

> Could the theory of relativity be more complicated?
>
> Yes, the theory of relativity could be far more complicated. Indeed, the history of the theory of relativity is basically a sequence of simplifications, because each simplification was a step that led to the following simplification. Without those simplifications, very few people could understand it. Indeed it is uncertain whether relativity could ever have been discovered without those simplifications. [677]

Any major scientific paradigm is a breakthrough which most

often works this way. [678] Quantum gravity is no different. It will get less complex as time moves on. Quantum gravity shows how the quantum world gives rise to gravity or the geometric curvature of spacetime. It shows how gravity is created by discrete quanta. As in Einstein's day, there were traditional physicists that resisted and detested relativity, quantum gravity is no different now. In spite of all the work coming out, it has not been proven by physicists' high standards yet. There is a reason for this.

> Gravity is a very odd 'force' relative to the other forces. It is magnitudes weaker than the other forces in terms of locality.
>
> Gravity is a real weakling – 10^{-40} times weaker than the electromagnetic force that holds atoms together. Although the other forces act over different ranges, and between very different kinds of particles, they seem to have strengths that are roughly comparable with each other. [679]

However, over much larger regions, it is strong enough to bend time and space.

> The gravitational force is surprisingly weak—it is only because gravity is always attractive that we notice it at all. Our weight is the gravitational force due to the entire Earth acting on us. On the very large scale, as in astronomical systems, the gravitational force is the dominant force determining the motions of moons, planets, stars, and galaxies.[680]

Gravitons

If gravity is discrete, composed of quantum particles, it must have a quantum particle. Physicists already know a number of the properties it would have to have. Physicists even have a name for this new quantum particle, a graviton. Gravitons would have to

have a spin of two. This would mean that gravity only attracts.

> Electromagnetic forces are transferred between charged particles through the exchange of massless, force-carrying bosons called photons, which are also the particle components of light. The force-carrying photons that swap between charged particles, however, are a different manifestation of photons. They are virtual and undetectable, even though they are technically the same particles as the real and detectable version, according to the University of Tennessee, Knoxville.[681]

Electromagnetism attracts and repels. Electromagnetism is a force transferred between charged particles. Photons are massless, force-carrying bosons. Bosons are particles with integer spins of 0, 1, and 2. Bosons are extroverts. They love to party with other particles. They are responsible for electromagnetic interaction, the weak force, the strong force and gravitons. Fermions as particles with half spin like ½, 3/2, 5/2 etc. Fermions are introverts and loners. They like to stay in their room and study physics. Don't invite them to a party. They are Debbie Downers.[682] They are responsible for electrons and all molecular structure. Their antisocial behavior is what keeps electrons with the same charge from occupying the same shell of an atom. This is called the Pauli Exclusion Principle. It is the foundation of chemistry.[683] From general relativity, physicists are confident that gravity has an infinite range although some physicists have questioned that. In any case if its range were not infinite it would be very long. It is thought if there was a graviton it would have similar properties to this,

> For instance, we know that gravity has infinite range and can bind together distant galaxies. This means that the traditional graviton has zero mass. Further, empty space has no electrical charge in it, which means the graviton, which

would operate through empty space, must be electrically neutral.

More sophisticated thinking tells us what the quantum mechanical spin of the graviton must be. While the matter particles of the Standard Model are spin 1/2 and the Standard Model force-carrying particles have a spin of 1, gravitons must have a spin of 2. (This proceeds from the fact that gravity stems from the distribution of energy and momentum in the universe. The specific mathematical formalism is called a tensor. If you want to impress someone at a cocktail party, you can tell them that gravity originates in a stress-energy tensor of rank 2.)

It turns out that this spin thing is a big deal, as you can prove that any massless spin-2 particle must act exactly as a graviton is predicted to behave. Thus if we find a spin-2 massless particle, we'll know it's a graviton. This spin-2 behavior also explains the fact that conventional gravity only attracts, unlike electromagnetism, which both attracts and repels.

The fact that early on superstring theory predicted a massless, spin-2 particle is one of the sources of the theory's popularity over the decades. While the intractability of the theory has led to a waning of the community's enthusiasm for superstrings in recent years, it remains an elegant way to bring gravity into the quantum realm. Further, newer theories that predict additional spatial dimensions can allow massive spin-2 gravitons.[684]

In superconductors and entangled particles, we have the first afterglow of the Big Bang. Perhaps before the emergence of gravitons it was not hot yet but possibly supercooled. We know that in some of the early moments of the universe, before the familiar particles and structures formed, everything was hot, dense, and in perfect balance. Heat is a symptom of a loss of systems in

equilibrium and the indicator of entropy. However, something caused the equilibrium of what relativity deems the singularity to become unstable. Researchers have proposed various theories to explain this transition, but one intriguing possibility involves supercooled helium. In a recent study, scientists used supercooled helium to model conditions that may have existed just after the Big Bang. This would have been when all forces (gravity, electromagnetic, strong nuclear force, and weak nuclear force) were one. Gravity was the first to emerge somewhere around 10-43 seconds to 10-33 seconds. If the universe was supercooled it would have been before these times (although time had not been born yet but from our relative perspective, shall we say). Gravitons would have emerged around 10-43 seconds to 10-33 seconds. Before that, were there supercooled qubits in a metaphorical petri dish? In any case if gravitons were proven, before gravitons it seems to me there would have been no gravity. [685] And certainly, we know that the quantum wave function has no gravity associated with it.

I will get into the notion of how components in the wave function which are neither *real* nor *ideal* have semiclassical analogies which shed light on our classical universe but for now the question arises, "What semiclassical components in the wave function correspond to gravity?" This is what the whole field of quantum gravity and the holographic principle addresses in a nutshell. This will be discussed later. However, one can formally show that semiclassical gravity could be deduced from quantum gravity by considering N copies of the quantum matter fields and taking the limit of N going to infinity while keeping the product GN (**G**ravitation Constant of Einstein and **N**ewton) constant. [686] Perhaps we can think of it like this: While particles near Planck constant levels and below are not affected by gravitation, enough copies of the background, highly entangled, virtual particles which form zero-point energy, the 'background vacuum energy, could produce semiclassical gravity. [687] Another way to think about this is the entangled density in the wave function might have a dualistic

complementarity piece in spacetime called gravity. This will all be discussed in more detail later.

Just like the three forces have subatomic particles which give rise to them, gravity might have to have a subatomic particle as well. However, proving the existence of gravitons is practically impossible. This is due to the weakness of the force in terms of locality. Physicists already know that a graviton would have to have a mass of less than $7.7 \times 10 - 23$ eV/c2 (which is extremely low if it has any mass at all). A detector capable of measuring a graviton would have to have the mass of Jupiter and 100% efficiency and be placed in close orbit around a neutron star and would only be expected to observe one graviton every 10 years. This is a non-starter but there are other ways of proving it without having to directly observe a graviton. If math and observations of gravitons were to have a high amount of predictability, it would solve some of the biggest riddles including questions about the singularity of a massive blackhole. That would be a big step forward. Quantum gravity is well on its way to realizing that goal. Another case in point which lends credit to quantum gravity would be if we would detect gravity produced by a system of entangled particles. Quantum gravity appears to be a very likely candidate for finally and quizzically unifying gravity and quantum mechanics and ushering us to a strange new world with very exciting ramifications. I see the possibility for not only a paradigm shift in science but a hope for a very different and hopeful era in philosophy, culture, history, and language.

What seems to me to be the most promising signal that we may be at the forefront of a rare paradigm shift with quantum gravity is the synergy Leonard Susskind and many others have for quantum gravity research. This research seems to be expanding at an amazing pace. The question of how quantum gravity works with general relativity has been explored over the decades in a number of different ways. One way is to try to change the mathematics of general relativity called the Hamilton formulation to incorporate

quantum effects. Another way that was attempted to explain how quantum gravity works was to use perturbative approaches meaning that it was simply a disruption of the normal way physics understands gravity in general relativity. Two schools of theories emerged in the 1980s using string theory and loop quantum gravity to approach how gravity arises from quantum mechanics. These two approaches will be discussed later.

> The problem of quantum gravity has been with us for over 80 years. After quantum theory was established in the 1920s, it was successfully applied to the electromagnetic field. Over the years there have been many attempts to bring gravity into the fold. There has been work on the Hamiltonian formulation of general relativity, perturbative approaches to quantum gravity and more. Much intellectual effort went into understanding conceptual and technical problems stemming from the general covariance of the theory. However, in earlier decades, the subject of quantum gravity was relatively on the fringes of theoretical physics research, pursued by a small and diverse community of people.
>
> In the mid 1980s the situation changed dramatically. The subject of quantum gravity came to the forefront of fundamental physics research, no longer a backwater but the mainstream. Quantum gravity was widely acknowledged as the last frontier of fundamental physics and attracted the brightest young people. Unlike in previous decades, workers in this area were no longer isolated groups or individuals ploughing lonely furrows, but organized into coherent `programmes' for a concerted attack on the problem. The main programmes coincidentally were all formulated in the mid 1980s. The two `programmes' covered in this section are string theory and loop quantum gravity. String theory was born an offshoot of Hadronic models in particle physics and reflects the particle physicists view that gravity is just one

> more interaction to be encompassed by a unified theory. Loop quantum gravity reflects the general relativist's conviction that gravity is different and should not be treated as a perturbation about Minkowski spacetime. Each of these approaches has its proponents, adherents and critics. It is now about a quarter of a century since these programmes started. It is perhaps a good time to take stock and assess where we are now and where each of these programmes is headed.[688]

Ideas which led to current notions of quantum gravity have been around for almost one hundred years.[689] Quantum gravity is a theory which unites the very small and the very large. Over this time period budding research is gaining more and more acceptance and enthusiasm.[690] I will cite studies and give indications of where extremities may be hiding and taking root in quantum entanglement and [other related concepts]. quantum gravity. Some of these examples are more accepted than others. However, common themes and findings are emerging in increased areas of research. This is producing a similar kind of excitement as the major paradigmatic shifts in classic science.

Concerning physicist Leonard Susskind, an article entitled “Bad Boy of Physics” in the online magazine “Scientific American” [691] states Susskind transformed the status quo in physics. Forty years ago, Suskind co-founded string theory which eventually gained prominence as a leading unified theory of nature. A famous, decades long, battle argument between Susskind and Stephen Hawking was finally resolved when Susskind proved that information was not lost in a blackhole. If information were lost, this would violate a fundamental principle of physics which tells us that information cannot be destroyed. Susskind also used string theory to explain parallel universes and what he called “landscapes” which can be taken in an astronomical physics fashion the same way environmental landscapes have widely varied terrain. While

some of Susskind's string theories have fallen out of favor regarding basic principles, much of the mathematics developed in that period is still widely used in physics. Nowadays Susskind questions whether physicists can ever understand the universe as a product of basic principles.

MIT tells us,

> Quantum physics and Einstein's theory of general relativity are the two solid pillars that underlie much of modern physics. Understanding how these two well-established theories are related remains a central open question in theoretical physics. Over the last several decades, efforts in this direction have led to a broad range of new physical ideas and mathematical tools. In recent years, string theory and quantum field theory have converged in the context of holography, which connects quantum gravity in certain spacetimes with corresponding (conformal) field theories on a lower-dimensional spacetime. These developments and connections have deepened our understanding not only of quantum gravity, cosmology, and particle physics, but also of intermediate scale physics, such as condensed matter systems, the quark-gluon plasma, and disordered systems. String theory has also led to new insights to problems in many areas of mathematics.[692]

Just Discovered! Something that looks like a graviton!

Up until this recent discovery an elementary particle with a spin of two was not believed to exist. It was discovered in a fractional quantum Hall effect system (a condensed matter setting), not as the fundamental force-carrying particle of gravity in empty space. It is a "quasiparticle" discovery. In the upcoming section entitled "The Standard Model of Elementary Particles" will find that much is already known about what a graviton will have to look like. It will

be a boson like a photon. Bosons are super friendly and love to party together. It is believed that the graviton will have a mass of zero, also like the photon. It will have a charge of zero also like the photon. Its range, like the photon, is expected to be infinite. But now physicists have proven that a particle with a spin of two does exist. The experiment setup which proved that a spin-2 particle exists was a super-thin condensed matter, gallium arsenide layer in a semiconductor. The semiconductor was cooled to almost zero degrees Kelvin and exposed to a very strong magnetic field. This results in very strange electron behaviors. It also forms an incompressible liquid.

> This liquid is not calm but features collective motions where all the electrons move in concert, which can give rise to particle-like excitations. To examine those excitations, the team shined a carefully tuned laser on the semiconductor and analyzed the light that scattered off it.
>
> This revealed that the excitation had a kind of quantum spin that has only ever been theorised to exist in gravitons. Though this isn't a graviton per se, it is the closest thing we have seen. 693

At around 1,521 MeV (Mega electron-volts) the energy is very large compared to a photon which has about 1 MeV of energy. By Einstein's famous mass-energy equivalence ($E = mc^{2)}$ this is a large amount of energy but a very tiny amount of relativistic mass – basically massless. The photon and the discovery of a spin-2 particle have no rest mass and are considered massless. The study dated April 4, 2024, is not yet ready to call this a graviton but it does prove that some of the basic features of a graviton can exist! 694

And here is another recent report, a team of scientists from Columbia University, Nanjing University, Princeton, and the University of Munster discovered the first experimental evidence for a graviton-like particle in a quantum material. This particle is called

a chiral graviton mode (CGM) and exhibits spin-2 characteristics. CGMs were observed in a type of condensed matter known as a fractional quantum Hall effect (FQHE) liquid. These FQHE liquids are systems of strongly interacting electrons that occur in two dimensions at high magnetic fields and low temperatures. The discovery of CGMs provides insights into the fundamental forces of the universe and bridges the gap between quantum mechanics and Einstein's theories of relativity. 695

The Planck Scale

As mentioned, the main reason quantum gravity is harder to prove than quantum mechanics is because quantum gravity, unlike quantum mechanics, works in magnitudes much smaller than quantum mechanics. Quantum gravity has to work on the Planck scale. The Planck scale gives us units of measurement which are derived from four basic universal constants which are highly accurate and are used successfully many times in physics. Four important constants are the speed of light (c = 186,282 miles per second), the gravitational constant (G = $6.674 \times 10-11$ m3·kg−1·s −2), the reduced Planck constant (h = $6.62607015 \times 10-34$ joule-hertz−1), and the Boltzmann constant (kb = $1.380649 \times 10-23$ joule per kelvin). I will only cite a few Planck units which are relevant to this discussion.696 The Planck scale is really rooted in the speed of light. Since the cosmos has given us immense amounts of experimental evidence that the speed of light limits what we can confidently know of phenomena, this has a direct effect on time and space. Since Einstein showed that time and space are, so to speak, two sides of the same coin, we know that as we approach the speed of light time slows down (time dilation) and since space is time length gets shorter (length contraction).

The result of this phenomenon impacts not only the shortest time and smallest length we can observe but also the smallest amount of energy and mass we can observe. The Planck scale gives

us the smallest units at which physics, as we know it, breaks down and no longer makes sense. The smallest Planck length would be $1.61625518 \times 10^{-35}$ meters. It is believed that the smallest unit of Planck time is the time when quantum gravitational effects are likely to become important. The smallest Planck time would be $5.39124760 \times 10^{-44}$ seconds. The smallest units of energy and mass in which it is believed, at the current time, that quantum gravity becomes effective would be 1.22×10^{19} GeV (giga-electron volt) and 2.17645×10^{-8} kg. To go any smaller would be purely a metaphysical exercise as it would not have any ascertainable physical effect in physics as we know it. Here are some other units which are directly related to the speed of light:

smallest mass is $2.17643424 \times 10^{-8}$ kg
smallest area is 2.6121×10^{-70} m^2
smallest volume is 4.2217×10^{-105} m^3
smallest momentum is 6.5249 kg·m/s
highest unit of energy is 1.9561×10^{9} joule
largest force is 1.2103×10^{44} Newton
largest acceleration is 5.56×10^{51} m/s^2[697]

The Planck scale gives us a basis for thinking about the notion of quanta or discrete units in which anything could be called physical reality. Here is an interesting point related to this,

> Now both Newton's and Einstein's gravity predict that enough mass in a small enough space can produce a blackhole: a region with a gravitational field so strong that its escape velocity is greater than c [the speed of light]. When we put the two ideas together, we find that there is a scale small enough for virtual blackholes to exist. This is the Planck scale. On this scale, a blackhole can appear spontaneously — but very briefly — anywhere in space. So, examined on this scale, all of the weird, singular behavior associated with blackholes asserts itself, not just in remote astrophysical peculiarities, but everywhere and at all times.

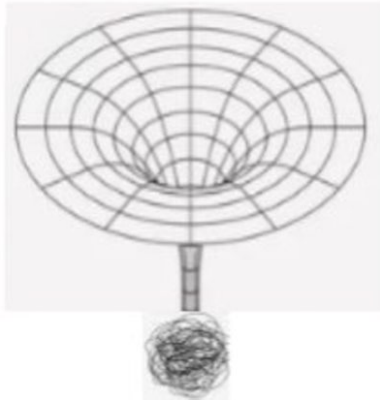
> With blackholes winking in and out of existence everywhere, space and time as continuous entities cease to have meanings when discussing distances of 10^{-35} meters and times of 10^{-44} seconds. So, relativity, a classical theory of space and time based on a spacetime continuum, might run into serious difficulties.[698]

Stanford Encyclopedia of Philosophy tells us,

> Quantum Gravity, broadly construed, is a physical theory (still 'under construction') incorporating both the principles of general relativity and quantum theory. Such a theory is expected to be able to provide a satisfactory description of the microstructure of spacetime at the so-called Planck scale, at which all fundamental constants of the ingredient theories, c (the velocity of light in vacuo), $\hbar$ (the reduced Planck's constant), and G (Newton's constant), come together to form units of mass, length, and time. This scale is so remote from current experimental capabilities that the empirical testing of quantum gravity proposals along standard lines is rendered near-impossible.[699]

The ancient Greek philosopher Democritus believed that the universe consisted of the smallest particle he called an atom. When what we call atoms were discovered, it was believed that the smallest particle had been found. This is how 'atom' got its name. However, we know from quantum physics that there are even smaller subatomic particles. Most schools of quantum gravity speculate that there is a quantum called a graviton which would be responsible for gravity. If so, the graviton would be among the smallest particles of Democritus. Current physics would limit Democritus' smallest particle to Planck dimensions.

The Four Forces



The Big Bang License Agreement

Physicists tell us there are four fundamental forces currently operating in our universe ordered from weakest to strongest:

1. Gravity or spacetime curvature is the attraction between objects which have inertial mass or energy. It is responsible for phenomena like planetary orbits, tides, apples falling from trees.
2. The weak force is responsible for particle decay. It explains how subatomic particles transform into other subatomic particles.
3. The electromagnetic force works between positively and negatively charged particles. Electromagnetic force is responsible for phenomena like light, friction, and elasticity.
4. The strong force holds the nucleus of atoms together. Specifically, protons and neutrons. 700

Gravity is 10^{-39} times weaker than the strong force. At the time of the Big Bang all of these forces were one. As the universe evolved these forces began to split apart into the four forces we currently have. Cosmology tells us how they think the four forces split off

from each other after the Big Bang:[701] The forces have had a long history. Here is a bit of information on them.

In the 4th century BC Aristotle observed that an intrinsic 'heaviness' caused objects to fall to the earth with heavier objects falling faster. Galileo in the 17th century proved Aristotle wrong when he discovered that all objects fall at the same rate regardless of 'heaviness'. Newton discovered the mathematics of the inverse square law of universal gravitation. This enabled Newton to derive Kepler's laws of planetary motion.[702]

As far back as the 4th century BC the Chinese were aware of magnetism. It was mentioned in a book called, "Book of the Devil Valley Master" which talked about it as a "lodestone" which makes iron come to it.[703] The ancient Egyptians and Greeks and later Arabs were also aware of the strange property. In 1865 James Clerk Maxwell (1831-1879) published a paper which showed equations which describe the relationship of electric and magnetic fields. Maxwell had shown that electromagnetic waves propagate at 186,000 miles per second with respect to the aether. A hundred years after Newton the mathematics of electromagnetism began to be understood as it obeyed the inverse square law of Newton except that it could be attractive or repulsive.

> James Chadwick discovered that the nucleus of each atom contains neutrons in 1932. Shortly after this, Eugene Wigner suggested that the electromagnetic force is not involved in holding the nucleus together and that there are two different nuclear forces. We now refer to these as the strong and weak nuclear forces.[704]

The ancient Greek word *aithêr* meant 'upper air'. Aether was a Greek god - the primordial god of light.

> Aristotle called it the fifth element. Alchemists thought it was the key to the philosopher's stone. Scientists believed it was

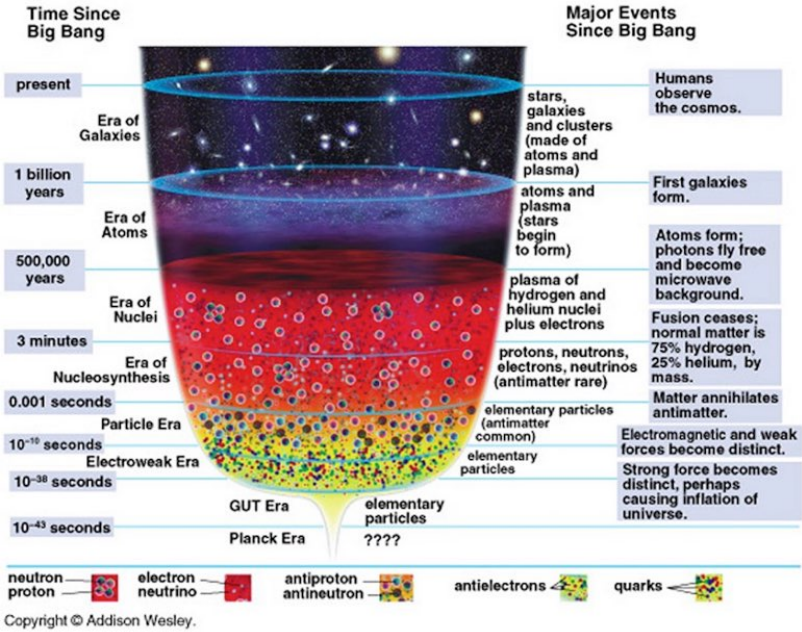
> the stuff light moved through. But it never existed at all… The aether was the invisible material thought to permeate all the empty space in the universe, used by famous thinkers from Aristotle to Isaac Newton to explain the mysteries of the natural world…Aether meant many things to many people. Ancient Greeks saw aether as the god of light and the fifth element of the universe. To the medieval alchemists, it was the fabled philosopher's stone that could turn lead into gold and prolong life. Centuries later, early modern scientists like René Descartes and Nikola Tesla were still pointing to aether to explain fundamental natural phenomena like gravity and light. Yet aether does not exist, and it never did. It may be the most enduring imaginary concept in scientific history.[705]

Even as early as 1896 when Einstein was 16 years old, he came up with the idea that a beam of light should propagate like an electromagnetic wave as well. At 16 years old Einstein already thought that the speed of light might be 186,000 miles per second. Initially, Einstein tried to conceive of experiments which could be conducted with the earth's motion through the aether. He soon decided the aether was not the way to go.[706]

Soon after Einstein's 1915 publication on general relativity he started work trying to show how general relativity was related to electromagnetism. Einstein was very impressed with Maxwell's mid-19th century electromagnetic !eld equations. These equations showed how the electric and magnetic fields were related. Einstein used these equations to try to find an explanation for gravity. He failed in this endeavor.[707]

Cosmology

Here is the current cosmological idea of the unfolding of the universe from the moment of the Big Bang,



1. Time 0 to 10^{-43} seconds – Planck Era

    a. Big Bang singularity
    b. infinitely small point
    c. infinitely hot
    d. infinitely dense
    e. all the four forces were one
    f. universe size is one Planck length (10^{-35} meters)

This is the moment of singularity. The singularity of the Big Bang was unimaginably hot and dense. Ever since the Big Bang, the universe has been expanding and cooling. According to general relativity, it is a single point with infinitely high energy density and infinite temperature.

- Time 10^{-43} to 10^{-38} seconds – GUT (Grand Unification) Era

a. gravity separates from the unification of the strong, weak, and electromagnetic forces
b. the strong force separates from unification and the weak and electromagnetic forces, called electroweak force, release a huge amount of energy
c. in 10^{-32} seconds, the theory of inflation expands the size of the universe by a factor of 10^{26} or from the size of an atomic nucleus to the size of our solar system in 10^{-32} seconds[709]

In the Grand Unification era we have good reasons from nuclear physics to understand how particles and forces evolved. Information we have in the Grand Unification era comes from quantum physics' information using large particle accelerators.

From 10^{-43} seconds to 10^{-35} seconds would be the Quantum gravity era. Theories like loop quantum gravity, superstrings, and supersymmetry theories give us plausible ideas (depending on the physicist you are asking) about what may have happened in this era.[710]

Gravity "freezes" out All particle types (quarks, leptons, gauge bosons, and undiscovered particles e.g. Higgs, sparticles, gravitons) and their anti-particles are in thermal equilibrium, meaning they are created and annihilated at an equal rate. They coexist with radiation (photons). Through a phase transition, gravity "freezes" out and becomes distinct in its action from the weak, electromagnetic, and strong forces. At this time, the other three forces cannot be distinguished from one another in their action on quarks and leptons. This is the first instance of the breaking of symmetry amongst the forces.[711]

10^{-35} seconds in the Grand unification era, inflation begins.

Inflation The rate of expansion increases exponentially for a short period of time. The universe doubles in size every 10^{-34} s. Inflation stops at around 10^{-32} s, by which time the universe has increased in size by a factor of 1050. This is equivalent to an object

the size of a proton swelling to 1019 light years across!

The whole universe is estimated to have had a size of ~1023 m at the end of the period of inflation. The universe we can see today, however, was only 3 m in size after inflation. This solves the problems of 'horizon' (how is it possible for two opposing parts of the present universe to be at the same temperature when they cannot have interacted with each other before recombination?) and 'flatness' (density of matter is close to the critical density).

t ≈ 10^{-32} s: **Strong force freezes out** Through another phase transition the strong force "freezes" out and a slight excess of matter over anti-matter develops. This excess, at a level of 1 part in a billion, is sufficient to give the presently observed dominance of matter over anti-matter. The temperature is too high for quarks to remain clumped to form neutrons or protons and so they exist in the form of a quark-gluon plasma. The LHC can study this by colliding together high-energy nuclei.[712]

1. Time 10^{-38} to 10^{-10} seconds – Electroweak era

    a. temperature of the universe is 10^{-15} Kelvin
    b. just photons (radiation) and pure energy exists
    c. electromagnetic and nuclear weak force separate around 10^{-10} seconds

Electromagnetic and Weak Forces separate The energy density corresponds to that at LEP. As the temperature falls, the weak force "freezes" out and all four forces become distinct in their actions. The antiquarks annihilate with the quarks, leaving a residual excess of matter. W and Z bosons decay. In general, unstable massive particles disappear when the temperature falls to a value at which photons from the black-body radiation do not have sufficient energy to create a particle-antiparticle pair.[713]

Photons or radiation existed but the universe was opaque so they could not travel far.

1. Time 10^{-10} to 0.001 seconds – Elementary Particle era

    a. "particle soup" where quarks and antiquarks, electrons and positrons, and other particles and antiparticles were created
    b. matter and antimatter created, 1 billion and 1 protons for each 1 billion anti-protons
    c. due to matter/antimatter collisions particles do not last very long and become pure energy again
    d. at 10^{-12} Kelvin or 0.001 second matter wins out

The battle between matter and anti-matter rages. Matter takes a very slight edge which is why we are here now.

- 0.001 seconds to 3 minutes – Nucleosynthesis era

    ○ first atomic nuclei began to form
    ○ around 10^{-4} seconds quarks start to combine to make protons and neutrons
    ○ cool enough to create heavier elements but universe is too dense for them to last long
    ○ at 10^{-9} Kelvin or 3 minutes later nuclei last longer
    ○ 75% hydrogen, 25% helium, trace amounts of other atoms went into making stars

Protons and Neutrons form The universe has grown to the size of our solar system. As the temperature drops, quark-antiquark annihilation stops and the remaining quarks combine to make protons and neutrons.

Neutrinos decouple The neutrinos become inactive (essentially, they do not participate further in interactions). The electrons and positrons annihilate and are not recreated. An excess of electrons is left. The neutron-proton ratio shifts from 50:50 to 25:75 [714]

- Time 3 minutes to 500,000 years – Nuclei era

- too hot to form neutral atoms
- hydrogen, helium, lithium nuclei and free electrons
- universe was ball of hot plasma
- photons and particles locked into equilibrium so photons not free yet

Nuclei is the scientific term for protons and neutrons.[715]

Nuclei are formed The temperature is low enough to allow nuclei to be formed. Conditions are similar to those that exist in stars today or in thermonuclear bombs. Heavier nuclei such as deuterium, helium, and lithium soak up the neutrons that are present. Any remaining neutrons decay with a time constant of ~ 1000 seconds. The neutron-proton ratio is now 13:87. The bulk constitution of the universe is now in place, consisting essentially of protons (75%) and helium nuclei. The temperature is still too high to form any atoms. Electrons form a gas of free particles.[716]

- Time 500,000 years to 1 billion years– Era of Atoms
  - at 3,000 Kelvin photons can escape plasma and travel through the universe
  - cosmic microwave background (CMB) may have started as early as 380,000 years
  - CMB is the earliest we can see
  - Could have started as early as 300,000 years after the Big Bang

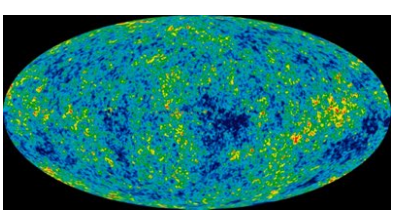
Atoms are created Electrons begin to stick to nuclei. Atoms of hydrogen, helium, and lithium are created. Radiation is no longer energetic enough to break atoms. The universe becomes transparent. Matter density dominates. Astronomy can study the evolution of the Universe back to this time.[717]

380,000 Cosmic Microwave Background

The temperature of space varies dramatically. Temperature is a

measure of the frenetic activity of atoms. We call this hot and cold but those are physical sensations we assign to this frenetic activity. Let's remember that the more heat we have, the less work can be achieved. Just after the Big Bang the universe was highly opaque. This is because atoms could not exist yet. A soup of subatomic particles and subsequent electrons and protons were unbound and stopped photons from traveling freely. This was pure chaos as Hesiod reminds us. Approximately 400,000 years after the Big Bang, the first atoms to exist were hydrogen atoms. This is called the 'last scattering'. This was the oldest possible time we have been able to see with special tools. It is called the Cosmic Microwave Background (CMB) of the universe.[718]

We can only 'see' as far back as the CMB. CMB is not visible light but microwave light. CMB was much hotter and more energetic 13 billion years ago. However, from our vantage 13 billion years later, it has cooled to a very cold 2.725 Kelvin and shifted into the microwave spectrum of light. Its peak frequency now is 160.23 GHz. CMB, as the earliest we can see back to the beginning of the universe, was somewhere around 380,000 years to 500,000 years after the big bang (depending on who you read). The CMB is a map of the young universe as 'noise' which was really pockets of heat that became visible only when the universe began to be transparent. Anything before that time will likely remain as theory since empirical observation could not occur in an opaque universe.



[719]

The picture above shows the infant universe CMB which came

somewhere around 375,000 years according to NASA after the Big Bang.[720]

- Time 1 billion years to Present – Era of Galaxies
  - galaxies form

Galaxy Formation Local mass density fluctuations act as seeds for stellar and galaxy formation (the exact mechanism is still not understood). Nucleosynthesis, the synthesis of heavier nuclei such as carbon up to iron, starts occurring in the thermonuclear reactors that are stars. Heavier elements are synthesized and dispersed in the moments when stars collapse and supernova explosions occur.[721]

Cosmological Facts

Physicists think they know how all the forces except gravity unfolded after the big bang. Since all four forces were united at the beginning, there must be a way to explain how gravity came about after the Big Bang. Quantum gravity is research into how gravity emerges just before inflation from quanta - gravitons.

The expansion of space is not like a fabric that keeps getting stretched out until you see empty spaces between the stitches of the fabric. Space expands by replicating itself at every point. Empty space or more precisely, virtual particles as vacuum energy, is continually being created to fill the spaces left by the expansion of the universe. (Susskind, 2008, p. 19) Additionally, space created during the inflationary period expanded very, very large compared to the speed of light. How can that be?

> Like everything else in physics, our Universe strives to exist in the lowest possible energy state possible. But around 10-36 seconds after the Big Bang, inflationary cosmologists believe that the cosmos found itself resting instead at a "false vacuum energy" – a low-point that wasn't really a low-point.

Seeking the true nadir of vacuum energy, over a minute fraction of a moment, the Universe is thought to have ballooned by a factor of 1050.[722]

The speed of light only applies to the interior of the universe. Outside the observable universe there is no reason why the universe cannot expand faster than the speed of light.[723] Inflation in the early cosmos is believed to get kicked off from a very large level of vacuum energy. For some reason, this created a metastable state which transformed the early universe in 10^{-32} seconds to the very small level of vacuum energy we see today.[724] While the Big Bang theory explains many things about our universe, there are problems with it as well. WMAP is the satellite which gave us the Cosmic Microwave Background data illustrated above.

The Flatness Problem: WMAP has determined the geometry of the universe to be nearly flat. However, under Big Bang cosmology, curvature grows with time. A universe as flat as we see it today would require an extreme fine-tuning of conditions in the past, which would be an unbelievable coincidence.

The Horizon Problem: Distant regions of space in opposite directions of the sky are so far apart that, assuming standard Big Bang expansion, they could never have been in causal contact with each other. This is because the light travel time between them exceeds the age of the universe. Yet the uniformity of the cosmic microwave background temperature tells us that these regions must have been in contact with each other in the past.

The Monopole Problem: Big Bang cosmology predicts that a very large number of heavy, stable "magnetic monopoles" should have been produced in the early universe. However, magnetic monopoles have never been observed, so if they exist at all, they are much more rare than the Big Bang

theory predicts.[725]

Cosmic inflation offers solutions to these problems.[726]

The Flatness Problem:

If you stood on a basketball, it would look very curved to you but if the basketball expanded to the size of the universe, it would look very flat to you now.

The Horizon Problem:

Cosmic inflation would explain why distant regions were much closer together prior to inflation and why they are so vastly farther away now.

The Monopole Problem:

If the magnetic monopoles were numerous prior to inflation, after inflation their density would have dropped to undetectable levels.

However, since the era of galaxies, the rate of expansion of the universe is determined by the ratio of mass pulling inward to the vacuum energy pushing outward. More on that later. From general relativity, if we could look from inside the time where photons could travel through a transparent universe it would be oddly different.

Two things should be noted at the earliest times of the Big Bang. We do not know about the earliest times before and around the Planck era. Since there were no photons or atoms, the current Planck values we discussed above only have relevance to later developments in the Big Bang.[727]

One thing we should note about the above diagram is that after the photon is born there is some time before it is able to travel through transparent spacetime. What we think as time begins when there is transparent spacetime. The time increments above are relative to our spacetime frame and what we think happened before there was a transparent universe. If any such thing as an observer could 'be' in these earliest beginnings of transparent spacetime (which would be impossible), the observer would likely experience

their time no differently than how we experience time. In Einstein's general relativity, from their relativistic frame, they could experience a whole 'lifetime'. However, in our relativistic frame it could look static, as if it were frozen in time. Anything which entered into the event horizon of a blackhole would also look frozen in time from our relativistic frame.

Time is problematic to say the least. Later in this book I will delve more deeply into time. For now, let's take a look at the predominant notion of time from the perspective of the Big Bang. Light has a finite speed. From where we sit, we can look back through time by looking out towards space. Remember space is time and time is space. From our relative frame of spacetime we can see an ancient order unfolding which emanates from a singularity.

> One consequence, as physicists Stephen W. Hawking and Roger Penrose proved in the 1960s, is that time cannot extend back indefinitely. As you play cosmic history backward in time, the galaxies all come together to a single infinitesimal point, known as a singularity--almost as if they were descending into a blackhole. Each galaxy or its precursor is squeezed down to zero size. Quantities such as density, temperature and spacetime curvature become infinite. The singularity is the ultimate cataclysm, beyond which our cosmic ancestry cannot extend.[728]

What is a singularity?

The idea of singularity as 'infinitely small' makes no sense because small indicates a determination of size. When infinity (infinitesimal) is applied to a singularity, the logical word which comes to mind is the idea of nothing, but a singularity is never nothing. A singularity forever approaches nothing.

> Modern cosmology contents itself with reconstructing the present and past events of cosmic history, starting from

> observations, laboratory experiments and the theoretical models believed to best represent the Universe. Within the framework of big bang models, it tries, as closely as possible, to approach the conditions that might have presided at the "appearance" of space, time, and matter during an event extrapolated into the past, the big bang. The mathematical nature of the big bang - that of a singularity where the curvature of space-time is infinite - implies in fact that the big bang does not belong to the space-time geometry. The big bang is therefore not even an event. It has not taken place and has no location. Similarly, it necessarily lies outside the domain of our present-day theories.[729]

So, singularity has a big ontological problem, it does not belong to spacetime geometry. A singularity with a curvature of infinity cannot exist. No laws of physics based on existence, what is or what can be in existence, can explain how singularities could possibly exist except as an abstract mathematical axiom. General relativity certainly qualifies as "laws of physics" and describes very accurately much of actual spacetime but when the mathematics of general relativity slips into singularities it has left actual laws that apply to our universe. How can "law of physics" cross from actual existence to describe a purely abstract singularity which cannot exist? If the big bang started as a singularity which cannot have any kind of a 'reality' as far as we know, how could reality emerge from pure abstraction explained by the infinities of mathematics? How can both existence and nonexistent abstraction both be true? Ontologically, this appears to be a logical contradiction. Can we concede that the mathematics of general relativity allows this contradiction and yet remains valid? Aristotle would disagree based on the law of non-contradiction! Heraclitus would not…

σάρμα εἰκῇ κεχυμένον ὁ κάλλιστος, φησὶν Ἡράκλειτος, [ὁ] κόσμος

The most beautiful universe is (a) pouring out (of) sweepings at

random.[730]

In any case we know that there is something we are missing when relativity arrives at a singularity in what is otherwise a sound ontological principle.

As we will see quantum entanglement which '*the characteristic trait of quantum mechanics'*, pervasive throughout the universe, is an abstraction par excellence with regard to cause and effect, spacetime, ontology, and yet it is generally believed now that cause and effect, spacetime, existence, and ontology is an emergent phenomenon of quantum entanglement. For now, I simply pose the idea that a singularity is exformation which has no 'reality' as we have been conditioned to think it. This is not a matter of what 'is' but what turns inwardly on us as what the '**is**' is that we think. We should not turn our assumptions into impossible demands to validate ourselves and our history but listen, leave open the very real possibility that we have not yet been configured historically, socially, linguistically to yet grasp the enigma of quantum entanglement.

With regard to singularity, what if a singularity is exformation? Instead of thinking that in a blackhole spacetime crunches reality, matter, ontology down to exformation, we should turn this idea around. It seems that spacetime emerges from exformation. Encoded in the information is how the unfolding of spacetime emerges. In cosmology this is called a white hole. First, let's briefly clarify what we mean by encoding and decoding.

By encoding and decoding we are not thinking about a fixed code system which, when applied to scrambled data will break the code and restore the original message. Any such notion as original does not exist in quantum mechanics. 'Original' only exists in the Western history of metaphysics. Anything and everything and every phenomenon go well below the level of thingness or objecthood. From the start it is spooky. In fact, there is no 'start'. There are no copies in quantum mechanics (to be discussed later). There is an absolute spooky, observational uniqueness, irreversible,

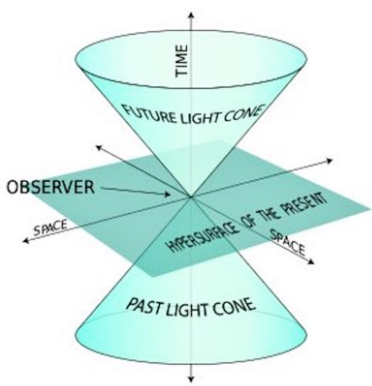
indeterminate, and nonlocal to phenomenon at the lowest way of thinking about it. So, the 'code' is not a code that unravels the 'original'. It is a code that unravels once again for the first time. Whatever gets 'decoded' cannot be duplicated, cloned, deleted, or hidden. All this will be explained in further detail later but the thing to remember now is that while I may use the words encoding, decoding, cloning, etc. these are merely for some sort of historical anchor to start to get you acclimated to something bizarrely different than what we can comfortably think about.

Instead of crunching spacetime down to exformation, a white hole spits out spacetime, matter, cause and effect, etc. However, if our universe is a white hole there is speculation that white holes and blackholes are both the same. One idea is that blackholes turn into white holes at some point. After the blackhole reaches a maximum amount of informational complexity determined by the two-dimensional area of the event horizon, the blackhole begins releasing its informational content back into the universe. Instead of taking in all matter which enters the blackhole's event horizon, the two-dimensional event horizon's encoded informational content is decoded back into three-dimensional space, the universe, as a white hole. Over time the white hole dissipates into nothing. In doing so, information is preserved, which is a long-standing requirement of physics.[731] Initially, Hawking argued that information was not preserved in a blackhole but was later convinced that information was preserved. Later I will talk about another idea of how this could work.

In the same way the waves are particles too, there is a complementarity aspect of a blackhole/white hole as well depending on your perspective. If you are on the outside of a blackhole it will look and act completely different from a physics and commonsense perspective than if you were on the inside in a complementary or contradictory fashion. I will discuss this more later in the 'Blackhole Event Horizon' section. Try that out at your next party (speaking as a fermion)!

In relativity, anything we can or will see, any event that can ever happen or will happen is limited by the speed of light. Our reality, both past and future, is limited by the fact that it takes longer than the speed of light to reach us (past) or will take longer than the speed of light to reach us (future), it will never be a part of our reality. Our present is moving towards the future too so all this changes dynamically as we move towards the future. In relativity's spacetime, our universe is limited by the speed of light – no exceptions. Physicists call this dynamic limitation the 'causal universe'. 732

Cause and effect, past and future, what we can observe, what can possibly happen, all take place within a bounded region of our moving present. Everything we see or can see is really only a result of the limitation of the speed of light. This is called the 2D space plus a time dimension light cone shown below.



733

The light cone dynamically demarcates the bounds of anything we call reality.

Think about the shape of the Cosmic Microwave Background, the universe, or the event horizon of a blackhole. They look like a flattened disc or sphere when looking from the side. The reason

they look like this is due to the limitation of the speed of light. Imagine you are on a boat in the middle of the ocean. For 360 degrees, you cannot see any land. What do you see? A flattened slightly curved horizon all around you. Whenever the speed of light is exceeded because it can never arrive at your relative location, it will look circular if you are looking at it straight on or, as you change your view to look at it from the side, it will look increasingly like a flat disc. Just because we 'see' the universe as a somewhat flat disk expanding does not necessarily mean that only nothing exists exterior to the expanding universe.

What we are describing as a flat expanding disk could equally be thought of as the event horizon of a blackhole. If our present day were the center of the event horizon of a blackhole, it would have the same shape as the horizon from the boat I discussed in the middle of the ocean. What you are seeing of a blackhole at the event horizon is when light can no longer reach you. Light has left your (our) universe. The point to all this is that our universe is not somehow stuck out in the middle of nothingness like a desert island. Anything beyond the visible universe can only be hypothesized from what we can observe. In the ocean analogy, if there are landscapes beyond the visible horizon you may be able to deduce it from the ocean currents you can observe. This will be especially important later when I discuss spacetime curves, currents of spacetime, which can help us understand multidimensional geometry, quantum gravity, blackholes, and the hologram effect, and 'land masses' we may as well call multiple universes. Susskind calls them landscapes...I like that better. All of this involves entanglement and information as we will see.

In any case, I have detailed the best cosmological ideas we have from many reliable sources of physics and astronomical information. There are other ideas like the Big Crunch where our universe expands for a while then contracts until it becomes another singularity. While this utilizes our current astronomical data it also has the problem of returning to singularity. Singularity

is consistent with general relativity. Infinities arise in general relativity because its mathematics is continuous and smooth.

Quantum physics is discrete and lumpy so nothing can be smaller than Planck levels meaning that an infinitely small singularity could not occur as matter. It may be that only exformation which is chaotic and indeterminate remains validating Hesiod. In cosmology, quantum physics gave us ideas concerning many worlds, multiple universes, or better M-Theory. The ancient idea of many worlds is again popular with physicists in the form of M-Theory. At the present time multiple universes is not so much from a cosmological point of view because it may never be able to be proved ontologically, but the mathematics that was developed in M-Theory still lives on in important work.

String theory mathematics is still contributing greatly to many areas of physics including quantum physics. Cosmologically, it is more difficult to get direct evidence of M-Theory but there still are some incredible indirect findings which have relevance to a lot of questions in our universe. String theory and further, multidimensional branes (M-Theory), can address ideas of dark matter and dark energy and Planck level questions in quantum physics. At present, geometry and multidimensional math can more eloquently explain certain phenomena in particle physics than alternative explanations. Additionally, these theories are consistent with the information updating of the quantum wave function which I will discuss later.

Another problem with our current cosmology is that it only accounts for 4 percent of the known universe. Together, dark matter and dark energy make up 96 percent of the universe. Like ‘gravity’, dark matter and dark energy are also prime candidates for the mathematics developed in string theory and ‘brane’ (membrane) theory.

It may be that we will never know for sure about multiple universes or what may lay 'beyond' the apparent 'event horizon' of our universe if anything. The 'beyond' in this case is due to the

speed of light. If there is a beyond to what we see of the universe, that light will never reach us. However, from the more reliable astronomical information we have we can 'see' an unfolding of spacetime the further we look back into space. We can even find good reasons for speculating before spacetime very close to the moment of the Big Bang singularity. Currently, we think the universe is 13.77 billion years old.[734]

> As such this fossil relic "frozen in" to the universe represents the last point when matter and photons were aligned in terms of temperature.[735]
>
> Why can we see it all?
>
> Imagine you are living 15 billion years ago. You would be surrounded by a very hot opaque plasma of electrons and protons. The Universe is expanding and cooling. When the Universe cools down below a critical temperature, the fog clears instantaneously everywhere. But you would not be able to see that it has cleared everywhere because, as you look into the far distance, you would be seeing into the opaque past of distant parts of the Universe. As the Universe continues to expand and cool you would be able to see farther, but you would always see the bright opaque fog in the distance, in the past. That bright fog is the surface of last scattering. It is the boundary between a transparent and an opaque universe and you can still see it today, 15 billion years later.[736]

At the time of the last scattering the CMB was estimated to be around 3,000 kelvins. It was a very hot plasma. Now due to the expansion of the universe CMB is around 2.7 kelvins. However, we now know that there is at least one place in the universe where the temperature is less than half a degree kelvin (-272.5 °C; -458.5 °F).

It is called the Boomerang Nebula.[737] Effectively, this means the Boomerang Nebula actually absorbs the cosmic microwave background from the last scattering.

Absolute Zero Kelvin

The heat death of the universe is very close to absolute zero Kelvin. However, here is the caveat,

> But it's completely theoretical. It's practically impossible to cool something down to Absolute Zero. In order to cool something down, you need to do work to extract heat from it. The colder you get, the more work you need to do. In order to get to Absolute Zero, you'd need to put in an infinite amount of work. And that's ridiculous.
>
> As you probably learned in physics or chemistry class, the temperature of a gas translates to the motion of the particles in the gas. As you cool a gas down, by extracting heat from it, the particles slow down.
>
> You would think, then, that by cooling something down to Absolute Zero, all particle motion in that something would stop. But that's not true.
>
> From a quantum mechanics point of view, you can never know the position and momentum of particles at the same time. If the particles stopped, you'd know their momentum (zero) and their position… right there. The Universe and its laws of physics just can't allow that to happen. Thank Heisenberg's Uncertainty Principle.
>
> Therefore, there's always a little motion, even if you could get to Absolute Zero, which you can't. But you can't extract any more heat from it.[738]

As far as we know, the coldest temperature ever made in the universe was made in a lab at 38 picokelvins or 38 X 10^{-12} K.[739] If

absolute zero kelvin was possible (but it is not) almost all kinetic activity would cease and almost all disorder would cease but not chaos. I must write 'almost' because random quantum jitter and fluctuations can never cease in quantum mechanics. Chaos taken in the special way of quantum mechanics is not a contrary of order but exformation, pre-spacetime, before cause and effect. This is why uncertainty and indeterminism of *phusis* cannot be taken up by the 'is' of history and the ease of thinking. If *phusis* was the '*is*' of history there would be absolutely no chaos and no possibility of doing work at absolute zero kelvin, random quantum jitter and fluctuations would not exist, and 'reality' would be the '*is*' of classicism and modernity. This would be the classical physics of 'the absolute' and determinism – the universe machine. In that case perhaps we could call zero kelvin an absolute singularity because it would take an infinite amount of work to get there. Interesting enough, because the kelvin scale is not defined by physics as the coldest temperature possible but as the lowest possible energy, it is possible to have negative kelvin.[740]

> Physicists have now created an atomic gas in the laboratory that nonetheless has negative Kelvin values. These negative absolute temperatures have several apparently absurd consequences: although the atoms in the gas attract each other and give rise to a negative pressure, the gas does not collapse – a behavior that is also postulated for dark energy in cosmology.[741]

Henceforth, remember negative pressure as a term that describes a situation in which an enclosed volume has lower pressure than its surroundings.

Entropy

Typically, as energy is added to a system, entropy increases. Let's

remember that entropy is a measure of disorder. In this case the notion of 'disorder' is relative to order. Disorder is a relative measure of order, the metaphysical 'not' of order. Physics has always said thermal systems in spacetime cannot violate the second law of thermodynamics. Almost all systems in spacetime will eventually move from more energy doing useful work to less energy to do useful work. Another way of saying this is most systems in spacetime tend towards increasing entropy or as stated before, "In most thermodynamic processes, the total entropy either increases or remains constant, but never decreases". However, in the laboratory we can make heat spontaneously flow from a colder body to a warmer one. How?

Negative entropy is a measure of less disorder or more order. In effect, we are over saturating entropy for a specific system which has a maximum amount of entropy. Forcing entropy above a certain amount for a specific system can only result in less entropy. The region of less entropy can only be done with a negative temperature. The enigma of this is that doing this will cause heat to go from a cold body to a hot body. This behavior can only happen when energy states have been artificially limited. Normally, matter has no limit to high energy states. Another way of saying this is when we go towards the singularity of zero kelvin, we can jump over absolute zero from positive kelvin to negative kelvin without going through the infinity mark at absolute zero by using an extremely high burst of energy. This immediately transports us to a place from high entropy to low entropy. This is opposite than what we would normally think would happen – when something heats something else, we expect the 'something else' to get hotter. However, because we over-saturated a body beyond its highest entropy, the heat applied to the over-saturated body makes it colder. This is a case where intuition fails and you just have to go, "that's quantum weirdness!". It is an odd case where more energy added to a system results in less entropy.[742] Here is how the Max Planck institute describes it,

In their experiment, the scientists first cool around a hundred thousand atoms in a vacuum chamber to a positive temperature of a few billionth Kelvin and capture them in optical traps made of laser beams. The surrounding ultrahigh vacuum guarantees that the atoms are perfectly isolated from the environment. The laser beams create a so-called optical lattice, in which the atoms are trapped in a perfectly ordered array of millions of bright light spots emerging from the interference between the laser beams. In this lattice, the atoms can still move from site to site via tunneling, yet their kinetic energy is limited from above and therefore possesses the required upper energy bound. Temperature, however, relates not only to kinetic energy, but the total energy of the particles, which in this case includes interaction and potential energy. The system of the Munich and Garching researchers also sets a limit to both of these. By suddenly turning a valley into a hill (and changing the interaction), the physicists then take the atoms to the upper boundary of the total energy – thus realizing a negative temperature, at minus a few billionth Kelvin.

"If balls possess a positive temperature and lie in a valley at minimum potential energy, this state will apparently be stable – this is nature as we know it. If the balls are located on top of a hill at maximum potential energy, they will usually roll down and thereby convert their potential energy into kinetic energy. If the balls are, however, at negative temperature, their kinetic energy will already be so large that it cannot increase further. Therefore the balls cannot roll down and stay on top of the hill. The energy boundary therefore renders the system stable!" explains Simon Braun, PhD student in the group. The negative temperature state in their experiment is indeed just as stable as a positive temperature state. "That way, we have created the first negative absolute temperature state for moving particles," he

adds.

Matter at negative absolute temperature leads to a whole bunch of astounding consequences: With its help, one could create heat engines with an efficiency above 100%. This does not mean that the law of energy conservation is violated. Instead, the machine could not only absorb energy from the hotter substance, but, in contrast to the usual case, also from the colder. The work performed by the engine could therefore be larger than the energy taken from the hotter substance alone.

The achievement of the Munich physicists could additionally be interesting for cosmology. Concerning its thermodynamic behavior, negative temperature states exhibit parallels to the so-called dark energy. Cosmologists postulate dark energy as the elusive force that accelerates the expansion of the universe, although the cosmos should in fact contract because of the gravitational attraction between all masses. There is a similar phenomenon in the atomic cloud in the Munich lab: The experiment relies upon the fact that the atoms in the gas do not repel each other as in a usual gas, but instead interact attractively. This means that the atoms exert a negative instead of a positive pressure. As a consequence, the atom cloud wants to contract and should usually collapse – just as is expected for the universe under the influence of gravity. But because of its negative temperature this does not happen. The gas is saved from collapse just like the universe.[743]

So, can we use negative temperature for nuclear fusion? No. Here is why,

The thermodynamic definition of temperature is based on the way that the entropy of a system changes as we increase the energy. We expect that as we increase the energy of a system

it will become more disordered and its entropy will increase, and this corresponds to the usual positive temperatures that we measure with a thermometer.

However there are systems where the entropy has a maximum value, and as we keep increasing the energy the entropy passes through a maximum and starts decreasing again. When the entropy is decreasing with increasing energy this corresponds to a negative temperature.

This is why we say negative temperatures are higher energy than positive temperatures, though the way you sometimes see this stated in popular science articles can be misleading. The energy of a system increases smoothly as we heat it, and the negative temperature is just telling us about how the disorder in the system is changing as we heat it.

It is certainly true that in the case of fusion we want as much energy as possible in our fusing gas, so we heat it as much as we can. However a hot gas is not one of the systems where the entropy can decrease with increasing energy so it won't develop a negative temperature as we heat it.[744]

Fusion Announced

On December 5, 2022, for the first time in human history, Lawrence Livermore National Laboratory announced it had performed the first controlled fusion![745] In effect, fusion is a super-perpetual motion machine. This is like an effect of negative entropy. Negative entropy means the more energy you put into a system, the less entropy you have in the system. When isotopes of hydrogen, deuterium and tritium, fuse, they create a helium nucleus, which has two protons and two neutrons and helium nuclei or alpha particles. The reaction releases an energetic neutron. In turn, this ignites fusion process. The process used by the lab involved putting the hydrogen isotype into a solid gold container and dropping the temperature to close to absolute zero, 18 Kelvin or -427 º

Fahrenheit. Then, 192 lasers blast the isotope heating the isotope up to 60 million Kelvin or 108 million degrees Fahrenheit.[746] Fusion in the core of the sun is 15 million Kelvin or 27 million degrees Fahrenheit. This means the Lawrence Livermore National Laboratory hit the isotope with four times the heat of the sun's core. Here is a description of the process,

> The facility trains 192 laser beams into a 1-cm-tall, hollow, gold-lined cylinder known as a hohlraum, shown in figure 1, that suspends the capsule inside it. After absorbing UV-laser light, the hohlraum's interior wall reradiates a flux of soft x rays. Within 8 ns, those x rays accelerate and compress the hydrogen isotopes into a hot spot half the width of a human hair at a temperature of 60 million kelvin and a pressure of 350 billion atmospheres.
>
> Under the capsule's surface the hydrogen fuel resides as a thin shell, cooled to 18 K prior to compression. The colder the fuel is initially, the more compressible it is—and hence the hotter and denser it becomes. The fuel's own inertia provides enough delay between the implosion and its sudden deceleration for the strong nuclear force to convert a small fraction of isotope pairs into neutrons and helium nuclei, or alpha particles.[747]

The U.S. Department of Energy released a statement on December 13, 2022, stating.

> LLNL's experiment surpassed the fusion threshold by delivering 2.05 megajoules (MJ) of energy to the target, resulting in 3.15 MJ of fusion energy output, demonstrating for the first time a most fundamental science basis for inertial fusion energy (IFE).[748]

Here is one interesting hypothetical possibility for increasing the

length of quantum coherence. What if we could put multiple quantum computers which are quantum entangled systems in outer space satellites where temperatures are close to absolute zero. There are even more interesting ways of getting closer to absolute zero kelvin once satellites in space bring us closer. This will be discussed more later.

First Look at String Theory

It should be noted that while all these theories have important problems, they are not all mutually exclusive. Important parts of the math developed for superstrings and supersymmetry are also applicable to quantum gravity. String theory is highly mathematical. String theory's start in the sixties started investigating the peculiar behavior of one small particle called a hadron. It was thought of at that time as a point particle. Susskind writes,

> String Theory had one more difficulty. It was either a "theory of everything" or a "theory of nothing." The original goal of String Theory was to describe hadrons—nothing more. The electron, photon, and graviton were to remain point particles. Experiments over the years had taught us that electrons and photons, if they had any size at all, were vastly smaller than hadrons. They might as well be mere points as far as anyone could tell. On the other hand, hadrons are obviously not points. A point cannot be spun about an axis. When I think of spinning an object, I think of a pizza chef spinning a wad of dough or a basketball player spinning the ball on his finger. But you can't spin an infinitely small point. Hadrons can be easily spun: the excited spinning hadrons were encountered regularly in many accelerator laboratories. Hadrons must be more like a wad of dough than a mathematical point. 749

Note that 'point particles' are best thought of as points at larger scales but have a history of being made up of smaller 'point particles' when we look deeper. When we get to the smallest Planck scales, it would make 'point particles' impossible to 'see' directly. This is where the mathematics of strings, branes, and multiple dimensions beyond four, three of space and one of time, coalesce into geometric shapes. Recall that Einstein showed that spacetime geometry is responsible for gravity as well. Gravity is a uniquely odd force which may make two-dimensional space look like three-dimensional space which we see.[750] More on this later but let's go back to point particles for now.

Interestingly enough, Susskind traces these early sixties tendencies to look at phenomenon as a point or a black box with inputs and outputs to the rise of behaviorism in the sixties. He writes,

> A peculiar ideology insinuated itself into the high-energy theoretical physics of the 1960s. It paralleled almost exactly a fad that had taken hold in psychology. B. F. Skinner was the guru of the behaviorists, who insisted that only the external behavior of a human being was the proper material of mind science. According to Skinner, psychologists had no business inquiring into the inner mental states of their subjects. He even went so far as to declare that no such thing existed. The business of psychology was to watch, measure, and record the external behavior of subjects without ever inquiring about internal feelings, thoughts, or emotions. To the behaviorists a human was a black box that converted sensory input into behavioral output. While it is probably true that Freudians went too far in the other direction, the behaviorists carried their ideology to extremes. [751]

There is a conservative tendency in physics to want to explain the behavior of phenomena without overturning the current

paradigm. Thus, at one time the atom was considered the smallest particle in agreement with the ancient Greek philosopher Democritus. Eventually, electrons and the nucleus of an atom were discovered. After that the internal particles of nuclei were found to be made up of protons and neutrons. There was a reason for this distrust of looking deeper into the established norms. When new discoveries begin, they are very unsettled and tend to be highly over complicated and even wrong.

Psychology and philosophy have also suffered from wandering in the desert of abstractions for 40 years or longer. However, after the sausage gets made and new discoveries graduate to more comprehensive simplicities, they become the new paradigm as Thomas Kuhn wrote about in his sixties book “The Structure of Scientific Revolution”. (Kuhn, 1962) The same happened for string theory. Actually, the initial string theory which explained the behavior of hadrons is still used in physics and accepted a bedrock behavior of the phenomenon. Susskind tells us,

> In the thirty-five years since the discovery of String Theory, the stringy nature of hadrons has become a well-established experimental fact. 752

The real problem which exacerbated the abstractions of string theory seems to have been the desire to integrate string theory with point particles, the black box. It turns out that either all phenomena on the quantum scale are string-like or none is. String theory cannot exist with a mix of point particles and strings. I find this to be analogous to the complementarity principle.

We know that quantum behavior is both particle-like and wave-like depending on what the experimenter is looking for. It seems to me that it is likely that on different levels of description or information quanta can be thought as particle-like or string-like. A string is a wave. Think of plucking a guitar string. The audio waves vary in discrete states we call harmonic frequencies. Quanta means

discrete states. Just as the shells of electrons in atoms have discrete energy levels, these energy levels are arranged in fixed distances from the nucleus as 'harmonic states' set by the length of the string or the composition of the nucleus of the atom. String theory is attractive because it created mathematics which made quantum gravity possible. Even more, remember the geometry of Einstein's general relativity where the distortions of spacetime were geometric? String theory is the mathematical geometry of Planck size wavicles. This is where gravitons are thought to exist - the discrete unit or quantum of energy which composes the force of gravity.

Gravitons and Gravitational Waves

The Grand Unification era is exactly the kind of environment where quantum gravitational theory operates. Gravity is orders of magnitude weaker in smaller increments of spacetime at the present time. Any quantum theory of gravity could only be directly experimentally verified close to Planck scales. In practical terms this is impossible. There must be a quantum gravity theory that can explain how gravity came about and how it functions because gravity evolved very soon after the Big Bang in the Grand Unification era. Prior to the Grand Unification era anything we think of as 'existence' would be null and void. The Grand Unification era was where quantum gravitational theory would have to operate. Furthermore, we know that quantum physics came about in the electroweak era where matter and anti-matter annihilated each other making existence indeterminate. The electroweak era was before nuclei could exist in the latter end of nucleosynthesis. This was before there was any such thing as atoms composed of quanta. Quantum mechanics explains how quanta creates atoms. Quantum gravity is the theory which would bridge the indeterminate abyss of the very early universe where existence and non-existence had not yet settled out to the gravitational world,

from the very small to the very large. Most quantum gravity theories assume an almost close to Planck size quantum particle called a graviton. If gravitons exist, they will operate as the essential building block of gravity.

> Many physicists assume that gravitons exist, but few think that we will ever see them. These hypothetical elementary particles are a cornerstone of theories of quantum gravity, which seek to unify Albert Einstein's general theory of relativity with quantum mechanics. But they are notoriously hard — perhaps impossible — to observe in nature.
>
> The world of gravitons only becomes apparent when you zoom in to the fabric of spacetime at the smallest possible scales, which requires a device that can harness truly extreme amounts of energy. Unfortunately, any measuring device capable of directly probing down to this "Planck length" would necessarily be so massive that it would collapse into a blackhole. "It appears that Nature conspires to forbid any measurement of distance with error smaller than the Planck length," said Freeman Dyson, the celebrated theoretical physicist, in a 2013 talk presenting a back-of-the-envelope calculation of this limit.
>
> And so gravitons, according to conventional thinking, might only reveal themselves in the universe's most extreme places: around the time of the Big Bang, or in the heart of blackholes. "The problem with blackholes is that they're black, and so nothing comes out," said Daniel Holz, an astrophysicist at the University of Chicago. "And the quantum gravity stuff is happening right at the center of this — so that's too bad."[753]

While gravitons cannot be measured directly there may be another way. Einstein predicted the existence of a phenomenon called gravitational waves. Enormous cataclysmic events in the

universe can create gravitational waves like waves in the ocean in the actual fabric of spacetime.

> Gravitational waves are 'ripples' in spacetime caused by some of the most violent and energetic processes in the Universe. Albert Einstein predicted the existence of gravitational waves in 1916 in his general theory of relativity. Einstein's mathematics showed that massive accelerating objects (such as neutron stars or blackholes orbiting each other) would disrupt spacetime in such a way that 'waves' of undulating spacetime would propagate in all directions away from the source. These cosmic ripples would travel at the speed of light, carrying with them information about their origins, as well as clues to the nature of gravity itself.[754]

Gravitational waves were even emitted from the Big Bang itself and can be detected now using the earliest data we have from the cosmic microwave background data.

> A curved signature in the cosmic microwave background light provides proof of inflation and spacetime ripples. Physicists have found a long-predicted twist in light from the big bang that represents the first image of ripples in the universe called gravitational waves, researchers announced today. The finding is direct proof of the theory of inflation, the idea that the universe expanded extremely quickly in the first fraction of a nanosecond after it was born. What's more, the signal is coming through much more strongly than expected, ruling out a large class of inflation models and potentially pointing the way toward new theories of physics, experts say.[755]

Within days of completing new advanced detectors at the Laser Interferometer Gravitational-Wave Observatory (LIGO), the first

discovery of gravitational waves was detected on September 14, 2015, at 5:51am EDT. This was the first direct measurement of the existence of gravitational waves.

> This deeper search for gravitational waves began in September 2015, and within days, LIGO's "advanced" detectors achieved what Initial LIGO could not accomplish in 8 years of operation: On September 14, 2015, LIGO's interferometers in Livingston, LA and Hanford, WA made the world's first direct detection of gravitational waves, heralding a new era in astronomical exploration. The gravitational waves detected by LIGO on that day were generated by two blackholes colliding and merging into one nearly 1.3 BILLION light years away![756]
>
> Now LIGO has made the first direct observation of gravitational waves with an instrument on Earth. The researchers detected the gravitational waves on September 14, 2015, at 5:51 a.m. EDT, using the twin LIGO interferometers, located in Livingston, Louisiana and Hanford, Washington.[757]

Gravitational waves are waves of gravity or spacetime curvature which travel at the speed of light, 186,000 miles per second.

> A gravitational wave is an invisible (yet incredibly fast) ripple in space. Gravitational waves travel at the speed of light (186,000 miles per second). These waves squeeze and stretch anything in their path as they pass by. [758]

Gravitational waves can travel at the speed of light because they have no mass. They are called massless. All massless particles travel at the speed of light in vacuum.

Einstein's theory of General Relativity predicts that the speed

of gravitational waves exactly equals the speed of light in vacuum. This is not a coincidence. In modern physics, all massless particles/waves travel at the speed of light in vacuum. This includes gravitational waves which propagate changes in the gravitational field, light waves which propagate changes in the electromagnetic field, and gluons which propagate changes in the strong nuclear force field. In fact, the phrase "speed of light" can be misleading as it seems to make light look special. A better name would be "the universal speed limit", or "the speed of massless particles".[759]

Massive events create these gravitational waves such as,
when a star explodes asymmetrically (called a supernova)
when two big stars orbit each other
when two blackholes orbit each other and merge[760]

With more sensitive gravitational detectors coming out at the Laser Interferometer Gravitational-Wave Observatory, it may be possible to determine the existence of gravitons indirectly. If gravitons exist, they could show up as very low-level noise in gravitational wave data.

Detecting gravitons would prove gravity is quantum. However, because gravity is extraordinarily weak, scientists would need extraordinarily powerful instruments to detect these hypothesized particles.

"For a long time, there was this belief that quantum gravity effects couldn't possibly be experimentally observed, because the extreme energies involved would require particle accelerators the size of the solar system," said study lead author Maulik Parikh, a theoretical physicist at Arizona State University in Tempe.

Now researchers find there may be another way to see if gravity is quantum, based on the fuzzy nature of quantum mechanics. "Newly developed gravitational wave detectors

can, if we're lucky, reveal evidence for the quantization of gravity," Parikh said.

Quantum physics suggests the universe is often an uncertain place. For instance, electrons are often thought of as pointlike particles, but quantum physics suggests they should often be described as clouds around atomic nuclei where they may likely be found.

In the new study, the scientists treated gravitational fields like any other quantum field, like a magnetic field. This means objects experiencing gravity would encounter the same kind of random fluctuations, or noise, typically found in quantum mechanics.

If gravity is quantum, two bodies drawn toward one another due to gravity would be subject to random fluctuations in their motions. For example, an apple falling toward Earth would not drop straight down but would be subject to minute quantum jitters that one could envision arising due to bombardment of the apple by gravitons.

"It may not be impossible to detect the existence of the graviton," said study co-author George Zahariade, a theoretical physicist at the Autonomous University of Barcelona.

The researchers suggest this noise is potentially measurable in spacetime ripples known as gravitational waves, which are theoretically made up of gravitons. Scientists discovered the first direct evidence of these waves in 2015 with the Laser Interferometer Gravitational-Wave Observatory (LIGO), which senses the distortions that gravitational waves cause as they zip through matter.

Although the scientists estimated this quantum noise was typically unmeasurably small, they suggested there were theoretically predicted though as yet unobserved circumstances that could be "loud" enough for existing gravitational-wave observatories to detect. These include the

> very early universe, when the cosmos experienced a growth spurt known as inflation, "and perhaps also during the end stage of blackhole collisions," Parikh said. "If we're really lucky, the noise of such states could already be present in the data from our instruments, and just needs to be teased out."
>
> The circumstances in which this noise is large enough to be measurable "are rather special, and may not occur in nature," cautioned theoretical physicist Erik Verlinde at the University of Amsterdam, who did not take part in this research. Still, "their results give a strong motivation to start analyzing the noise in gravitational wave interferometer experiments," he added.[761]

In all our lives we have experienced gravitational waves without ever knowing it. If everything around us and ourselves increases by ‘x’ distance and decreases by ‘x’ distance, it all looks the same to us. And it has and will again while we walk around thinking everything is fixed and determinate.

Quantum Gravity and Time

In quantum gravity, time is emergent from more densely entangled quanta which is a result of geometry.

> As I described in an article this week on a new theoretical attempt to explain away dark matter, many leading physicists now consider space-time and gravity to be “emergent” phenomena: Bendy, curvy space-time and the matter within it are a hologram that arises out of a network of entangled qubits (quantum bits of information), much as the three-dimensional environment of a computer game is encoded in the classical bits on a silicon chip. “I think we now understand that space-time really is just a geometrical representation of the entanglement structure of these

underlying quantum systems," said Mark Van Raamsdonk, a theoretical physicist at the University of British Columbia. 762

From general relativity we know that space is time and time is space. In this sense, the phenomenon of temporality in general relativity confirms the idea that spatial geometry is fundamentally linked to temporality. But geometry itself is timeless. In cosmology quantum gravity emerges at the earliest moments from the singularity at 10^{-43} seconds from the unified force which later split into the four forces I already discussed. When gravity emerged there was no universe, no time or space as we think it from classicism. Likewise, when entangled geometry emerges as the force of gravity it is timeless.

> So, time is absolute in quantum theory, but dynamical in general relativity. What, then, happens if one seeks a unification of gravity with quantum theory or, more precisely, seeks an accommodation of gravity into the quantum framework? Obviously, time cannot be both absolute and non-absolute: this dilemma is usually referred to as the "problem of time". One can also rephrase it as the problem of finding a background-independent quantum theory.
>
> But does one really have to unify gravity with quantum theory into a theory of quantum gravity? In the next section, I shall give a concise summary of the main reasons for doing so. I shall then argue that one can draw important conclusions about the nature of time in quantum gravity without detailed knowledge of the full theory; in fact, all that is needed is the semiclassical limit – general relativity. I shall then describe the approximate nature of any time parameter and clarify the relevance of these limitations for the interpretation of quantum theory itself. I shall finally show how the direction of time can be understood in a theory

which is fundamentally timeless. 763

With regard to the term ‘semiclassical’, this term is what is properly used by quantum physics to describe what I have been referring to as analogies or metaphors between quantum physics and classical physics. As I discussed in the quantum wave function, there is also a timelessness, a simultaneity of all possibilities, which we, in order to make sense of quanta, must apply a unitary operator to as a pragmatic vehicle for understanding quantum states. This arises from the semiclassical necessity of thinking the wave function through the lens of classicism.

Fields

> A field is something that is present everywhere in space and time, can be, on average, zero or not zero, can have waves in it, and if it is a quantum field, then its waves are made from particles.764

Gravitons are both particle and wave just like all elementary particles. Waves in the ocean do not just appear. Waves in the ocean are created to a large degree by currents. They can also be created by land masses and shallower and shallower beaches. Currents, land, and beaches set up forces which result in oceanic waves. Let’s call these forces fields or force fields. Michael Faraday (1791-1867) was probably one of the greatest physicists of all time. Einstein was highly influenced by Faraday. Much of what we know about electromagnetic fields came from Faraday.

> It all goes back to Michael Faraday. Faraday was one of the great experimental physicists of all time, he was very much an experimental physicist, not a theorist. He left school at the age of 14. He knew essentially no mathematics. And yet rather wonderfully, he built up this intuition for the way the

> universe works. That meant he really made one of the most important contributions to theoretical physics. Over a period of about 25 years, he was playing with ideas of electricity and magnetism. He was getting magnets and wrapping copper wire around them. He did a couple of fairly important things like discover electromagnetic induction and invent the electric motor.[765]

Faraday discovered that magnets have fields. The fields were like invisible potential fields which had a direction or what Faraday called lines of force and an amplitude which were kind of a potential field which could have real effects on certain materials in the field. He also found that there were actually two kinds of fields, an electric field, and a magnetic field. It turns out they were both related to the flow of electrons through a wire. Additionally, the two fields were also ninety degrees out of phase with each other. These fields are called electromagnetic fields. Electromagnetic waves or ripples are what we call light. Light is made up of photons. Photons range from extremely low frequencies to extremely high gamma ray frequencies.

If we think about classical fields, imagine a point in a multi-dimensional coordinate system. If we focus close in on a particular point, there are two pieces of information on a small scale that will let us scale up on a larger scale – the location or position of the point and the momentum of the point. Keep in mind that momentum can have a translational component (e.g., as forward, backward, sideways, etc.) and an angular momentum (e.g., as spin or rotation which also has an effect on translation…think of a gyroscope).[766] In quantum mechanics this has an analogue to the wave/particle wavicle, where the position is related to the particle and wave is related to the momentum. However, because wavicles are not either/or but both/and the mathematics is more complicated and must necessarily deal with uncertainty or probability and how we observe the wavicle.

With this in mind, fields are a nice alternative. Why? Because a field can give us information about potentials in an area of space. We do not have to have actual wavicles to understand what would happen if a certain particle got into the field. Perhaps we can think of the field as pure potentiality and when a certain particle gets in a certain field, the potential energy gets converted into actual energy. The electromagnetic field has a wide spectrum of interactions on waves as wavelength and frequency and particles as photons. This is shown below.

Electromagnetic Spectrum Table

Class			Wavelength	Frequency	Energy per photon
Ionizing radiation	γ	Gamma rays	1 picometer	300 exahertz	1.24 megaelectronvolt
	HX	Hard X-rays	10 picometer	30 exahertz	124 kiloelectronvolt
	SX	Soft X-rays	100 picometer	3 exahertz	12.4 kiloelectronvolt
	EUV	Extreme ultraviolet	1 nanometer	300 petahertz	1.24 kiloelectronvolt
	NUV	Near ultraviolet, visible	10 nanometer	30 petahertz	124 electronvolt
	NIR	Near infrared	100 nanometer	3 petahertz	12.4 electronvolt
	MIR	Mid infrared	1 micrometer	300 terahertz	1.24 electronvolt
	FIR	Far infrared	10 micrometer	30 terahertz	124 meV
Micro-waves	EHF	Extremely high frequency	100 micrometer	3 terahertz	12.4 millielectronvolt
	SHF	Super high frequency	1 miillimeter	300 gigahertz	1.24 millielectronvolt
	UHF	Ultra high frequency	1 centimeter	30 gigahertz	124 microielectronvolt
Radio waves	VHF	Very high frequency	1 decimeter	3 gigahertz	12.4 microielectronvolt
	HF	High frequency	1 meter	300 megahertz	1.24 microielectronvolt
	MF	Medium frequency	10 meter	30 megahertz	124 nanoielectronvolt
	LF	Low frequency	100 meter	3 megahertz	12.4 nanoielectronvolt
	VLF	Very low frequency	1 killometer	300 kilohertz	1.24 nanoielectronvolt
	ULF	Ultra low frequency	10 killometer	30 kilohertz	124 picoelectronvolt
	SLF	Super low frequency	100 killometer	3 kilohertz	12.4 picoelectronvolt
	ELF	Extremely low frequency	1 miillimeter	300 hertz	1.24 picoelectronvolt
			10 millimeter	30 hertz	124 femtoelectronvolt
			100 millimeter	3 hertz	12.4 femtoelectronvolt

As you can see from the chart above gamma rays are very short wavelengths but very high energies. Since gamma rays are very high energy, have frequencies in the exahertz (quintillion hertz), have megaelectronvolts (million electronvolts), they are applicable to relativistic quantum physics.

> Accelerated particles develop in special environments where a small fraction of the particles can take on an "un-fair" share (or fraction) of the energy available. In such a system, a small number of particles can be accelerated to very close to the speed of light and carry a significant fraction of the energy available. Such energetic particles can then interact with the surrounding magnetic fields, matter or even with light, giving rise to high-energy electromagnetic radiation, such as gamma rays. Since the radiation emitted is not related to the temperature of the source, it is known as non-thermal emission.[768]

Gamma rays can occur in lightning, nuclear fission and fusion, quasars, supermassive blackholes, pulsars, dark matter, neutron stars and binary systems in which two orbitally entrapped massive stars or one massive star and a blackhole or neutron star collide.[769]

> Gamma rays have the smallest wavelengths and the most energy of any wave in the electromagnetic spectrum. They are produced by the hottest and most energetic objects in the universe, such as neutron stars and pulsars, supernova explosions, and regions around blackholes. On Earth, gamma waves are generated by nuclear explosions, lightning, and the less dramatic activity of radioactive decay.[770]

In 2017, two neutron stars collided producing gravitational waves which also produced gamma rays which a European Space Agency's Integral and NASA's Fermi satellites detected.[771] The Laser

Interferometer Gravitational-Wave Observatory (LIGO) facilities in the United States have detected four gravitation wave events so far.[772] As already discussed, it is believed that an upgrade to the LIGO sensors to detect a certain kind of noise in gravitational waves will be able to confirm the existence of gravitons.[773]

There is no well-defined limit to how far gamma waves can travel.

> The energy range of gamma rays is so vast that it doesn't even have a well-defined upper limit.[774]

Gamma Rays travel close to the speed of light. *Gamma rays are produced in the interactions of cosmic rays and provide the most sensitive means to study cosmic rays in and around their sources.*[775] It is believed that supermassive blackholes like at the center of our galaxy produces gamma ray jets.

> On a very different size-scale, supermassive blackholes are a million to a billion times more massive than the Sun and are assumed to exist in the centre of most galaxies, including our own. While the central blackhole in the Milky Way is only detectable through the orbits of stars moving around it, about 10 percent of known galaxies, so-called "active galaxies," harbour a supermassive blackhole that is fueled by a huge accretion disk (a rotating disk of material or gas formed by the blackhole's accretion). The very hot disk can outshine all the stars in the galaxy itself and can produce powerful outflows called "jets," in some cases longer than the diameter of the Milky Way.[776]

There is a new telescope array being built which will detect gamma rays propagating through intergalactic space from all kinds of catastrophic events in the universe including from the earliest times of the universe. It is called the Cherenkov Telescope Array

Observatory (CTAO). It will be operating in 2025 on the island of La Palma in the Canary Islands.[777]

> The gamma rays the CTAO will detect are about 10 trillion times more energetic than visible light.[778]

Very high energy gamma rays propagate in intergalactic space by producing electron positron pairs. The electron positron pairs generate secondary gamma rays which interact with intergalactic magnetic fields,

> Very-high-energy gamma rays produce electron positron pairs in interactions with low-energy photons of extragalactic background light during propagation through the intergalactic medium. The electron-positron pairs generate secondary gamma rays detectable by gamma-ray telescopes. This secondary emission can be used to detect intergalactic magnetic fields (IGMF) in the voids of large-scale structure.[779]

Detecting magnetic fields in the universe may be very helpful in finding cosmic voids. Cosmic voids were created in the earliest moments in the universe.

> Most of the Universe is very close to empty, with matter clustered into galaxy clusters, super-clusters and filaments, separated by huge voids. How empty these voids are is a matter of great debate. In particular, are there any tiny magnetic fields in these regions that are a relic of the earliest moments of the Universe? The CTAO will be able to probe magnetic fields in the voids via observations of halos around active galaxies and also help to probe the proposed heating of low-density regions in the Universe by TeV photon interactions. A known ingredient of the space between galaxy

> clusters is the extragalactic background light, the integrated light of all processes over the history of the Universe in the infrared to ultraviolet range. The CTAO will be able to characterize these radiation fields via the absorption features that they leave in the spectra of the population of active galaxies seen by the CTAO.[780]

As we have seen, there is a duality in the phenomenon of electromagnetism. Photons are both fields or waves and particles. We can think of electromagnetic fields as composed of many, many photons. Or we could think of electromagnetic fields as waves like in the ocean. Both would be correct. The same thing holds for other particles.

Quantum Fields

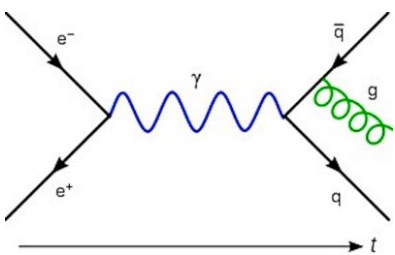
> A quantum field's waves cannot be of arbitrary intensity; they can't be arbitrarily `dim', or `quiet'. The least-intense possible wave that a field can have is called a "quantum", or more often is called a "particle". It often behaves in rough accordance with your intuitive notion of "particle", moving in a straight line and bouncing indivisibly off of things, etc., which is why we give it that name.[781]

Just as electrons are particles whose ripples set up electromagnetic fields spread throughout the universe so there are quark fields set up by quark ripples which are spread throughout the universe. Actually, there are six quark fields from six quark particles spread throughout the universe. Neutrinos create fields for gluons, the strong nuclear force of nuclei. W and Z bosons create the weak force responsible for nuclear decay and converting a neutron into a proton. This same holds for all the particles/fields in the Standard Model.

If you look closely enough at electromagnetic waves, you'll find that they are made out of particles called photons. The ripples of the electric and magnetic fields get turned into particles when we include the effects of quantum mechanics.

But this same process is at play for all other particles that we know of. There exists, spread thinly throughout space, something called an electron field. Ripples of the electron field get tied up into a bundle of energy by quantum mechanics. And this bundle of energy is what we call an electron. Similarly, there is a quark field, and a gluon field, and Higgs boson field. Every particle your body --- indeed, every particle in the Universe --- is a tiny ripple of the underlying field, moulded into a particle by the machinery of quantum mechanics.[782]

When we dig down into the weeds of particle interaction, we can get a better picture of how particles transform themselves. Just so you get an idea of how particle physics transforms itself incessantly, below is a Feynman diagram of how an electron is annihilated. On the left side of the diagram, we have an electron ($\mathbf{e}^-$) and a positron ($\mathbf{e}^+$) colliding and annihilating each other. A positron is an anti-electron. When they collide, a photon is released shown in the blue sine wave line. The photon becomes a quark ($\mathbf{q}$) and an antiquark ($\bar{\mathbf{q}}$) after which the antiquark radiates a gluon shown as a green helix.



Gluons give rise to hadrons. I discussed hadrons earlier as one of the early and still useful mathematics of string theory. One thing I did not mention is that most of the mass of ordinary matter comes from two hadrons: the proton and the neutron. This mass is due to the binding energy of quarks and gluons.[784] If quarks and gluons continue to be created with high energy, the quarks become bound to each by the gluons and the composite is called partons. The partons radiate at extremely low, unmeasurable energies producing hadrons. Quantum Chromodynamics is a theory of how quarks mediated by gluons produce the strong force of protons and neutrons.[785] Perturbative QCD in the quote below means that there is a deviation from the normal understanding of how the strong force operates, in this case because the energies of partons are too low to calculate.

> Perturbative QCD (Quantum Chromodynamics) can quantitatively describe the process of gluon radiation from the high energy initial quark and antiquark in $e+e- \rightarrow Z0/\gamma \rightarrow qq^{-}$. This gluon radiation process continues until the energy scale of the partons (gluons and quarks) approaches the hadron mass scale and color singlet bound states are produced. The hadronization process by which hadrons are produced from the radiated partons occurs at low energies where perturbative QCD calculations are not possible.[786]

As mentioned, the diagram above shows how matter and anti-matter as electrons and positrons transform into photons and then into quarks and gluons. Actually, *there are many hundreds of quarks and antiquarks and gluons inside a proton.*[787] Later, I will discuss vacuum energy and virtual particles. The important thing to remember from this discussion is how everything around us is pulling or pushing what it needs from vacuum energy or zero-point energy all the time. Vacuum energy is not something in deep space. It is constituent of everything around us and in us, in an incredibly

wonderful and dynamic way like a giant virtual particle reservoir – and all built around ***the*** *characteristic trait of quantum mechanics*… entanglement.

> But it's an extraordinarily complicated object, the proton. It, it's nothing nice and clean. It contains these hundreds, possibly even thousands of different particles interacting in some very complicated way. You could think about these quark-antiquark pairs as being, as you say, virtual particles, things that just pop out of the vacuum and pop back in again inside the proton. Or another way of thinking about it is just the fields themselves are excited in some complicated fashion inside the proton or neutron thrashing around and that's what's giving them their mass.[788]
>
> Many physical effects attributed to zero-point energy have been experimentally verified, such as spontaneous emission, Casimir force, Lamb shift, magnetic moment of the electron and Delbrück scattering. These effects are usually called "radiative corrections". In more complex nonlinear theories (e.g. QCD) zero-point energy can give rise to a variety of complex phenomena such as multiple stable states, symmetry breaking, chaos and emergence. Many physicists believe that "the vacuum holds the key to a full understanding of nature" and that studying it is critical in the search for the theory of everything. Active areas of research include the effects of virtual particles, quantum entanglement, the difference (if any) between inertial and gravitational mass] variation in the speed of light, a reason for the observed value of the cosmological constant and the nature of dark energy.[789]

A Deeper Dive – Lagrangian and Hamilton Mechanics

William Hamilton (1805-1865) [790] introduced Hamilton mechanics

which is a formulation of classical mechanics (e.g., Newton) in which the motion of the system is described through total energy by Hamilton's equations of motion. Earlier Joseph-Louis Lagrange (1736-1813) [791] had invented Lagrangian mechanics. Both Hamilton and Lagrangian mechanics are considered equivalent to Newton's mechanics, but these later mechanics are still widely in use in quantum physics as well. In Newtonian mechanics, we would look at all the forces acting on a particular object to describe its motion in terms of position and velocity. Think about the projection of a baseball. If we know the initial kinetic force that the pitcher applies to the baseball, which includes the baseball's mass and acceleration in a certain direction, and the potential force of gravity and force of wind resistance, we know the entire track and velocity that the ball will take. Instead of thinking in terms of the 'foreground', what the ball sees as forces upon it, what if we looked at the 'background', the space the ball moves in which determines how it will move? This is what Lagrange accomplished mathematically. The beauty of this is that as long as you know initial conditions, position and velocity, the field will dictate how any object will move once it is in the field, the background. This also lends itself to quantum fields. Additionally, math is much less complex. [792]

Lagrange's mechanics is based on the principle of stationary action. Stationary action is the use of energies to describe motion. Lagrange's mathematics asks what are the conditions for action being stationary? His mechanics has two basic concepts: the Lagrangian and the Principle of Stationary Action. The Lagrangian is a function which describes the state of motion for a particle through kinetic and potential energy. [793] Potential energy affects motion because it can be converted into kinetic energy like a ball rolling down a hill. The Principle of Stationary Action tells us to get the right equations of motions, the action which defines a path through space and time, it is required to be stationary. Instead of thinking of motion in terms of Newton's forces, motion can be

thought of as changes. To describe motion, we only need to know position and velocity and how these values change over time. Any motion is really just an optimization process between energies, kinetic and potential energy or Aristotle's actuality and potentiality. So, if we know if we know the position and velocity and changes will be a result of kinetic and potential energy. It turns out that actual objects and even fields will always behave and move in such a way that action is minimized or better, stationary. Why stationary? Think about how everything moves to thermal equilibrium. Also, everything moves to disorder, entropy. Exformation is not a cause and effect dynamic. Newton called this the path of least resistance and how objects in motion do not want to change their motion, they resist a change in motion. This is one of the most fundamental principles in all of physics. [794]

Hamilton mechanics is generally based on Lagrangian mechanics. Hamilton's new technique was meant for equations of motion. He called his principle "Varying Action" and was based on the calculus of variations. In particular, his mathematics was based on the symmetry between momentum and position. Hamilton is also credited with discovering the Lagrangian and Lagrange's equations. [795] Wow, what is the value of using Hamilton's mechanics over Lagrange's mechanics?

> The reason to step away from Lagrangian systems is that Hamiltonian systems link classical and quantum mechanics. More specifically, Hamiltonian systems are conservative, which can easily be extended to many physical systems. Furthermore, the biggest difference between Hamiltonian systems and Lagrangian systems is the fact that Hamiltonian equations have a larger set of symmetries. By applying these equations to physical systems, it is easier to exploit and manipulate the symmetries. Thus, Hamiltonian systems provide more tools to implement when trying to understand a physical system. [796]

The Hamilton operator of a system represents the total energy of a system.[797] In doing so, the conservation of energy makes Hamilton's mechanics more relevant for quantum fields. Remember that Lagrangian mechanics encodes continually changing kinetic and potential energies at each point in time. [798] The Hamilton operator can apply to a single particle, multiple particles, interactions between particles, and kinds of potential energy such as time varying or time independent potential energy. [799] Hamilton's mathematics is considered to be a classical approach which can easily be adapted to quantum problems. [800]

Hamilton mechanics describes the time evolution of motion through the *total energy of the system*. This is similar to the time evolution of motion through the kinetic and potential energy of the system. However, the total energy of a system stays constant but kinetic and potential energy changes continually depending on mass and initial conditions. Remember how in the last paragraph everything wants to stay the same, minimized, stationary, resist change? We can now add another factor, the total energy of a system that wants to stay constant. Hamilton mechanics typically look at the total energy of a system as a function of momentum and position, how position and momentum change with time. This also works with fields to describe momentum density.

Here's a quick step-by-step process to actually find the Hamiltonian of a system:

1. Construct the Lagrangian for the system through a set of generalized coordinates.
2. Find the generalized momenta from the Lagrangian.
3. Solve for the velocities in terms of the generalized momenta.
4. Insert the velocities in terms of momenta into the general form of the Hamiltonian.
5. Simplify. You should now have the Hamiltonian as a function of position and momenta. [801]

Hamilton's mathematics still finds uses in electromagnetism, quantum mechanics, relativity theory, and quantum field theory.

> The formulation that he devised for classical mechanics proved to be equally suited to quantum theory, whose development it facilitated. The Hamiltonian formalism shows no signs of obsolescence; new ideas continue to find this the most natural medium for their description and development, and the function that is now universally known as the Hamiltonian, is the starting-point for calculation in almost any area of physics.[802]

Uses for Hamilton mechanics are:

- thermodynamics and statistical mechanics
- perturbation theory (what happens when things are perturbed, and no profanity is involved) and chaos
- quantum mechanics and quantum field theory
- special and general relativity. [803]

The beauty of Hamilton mechanics is that it describes how a system changes with time in a way that lends itself to geometry. As I will discuss later, the geometric aspect of Hamilton's mechanics makes it very useful for quantum gravity and the holographic principle. Hamilton mechanics works really well for chaos theory. [804] For now, there are non-chaotic systems like oscillators, a pendulum for example, and chaotic systems. There are different types of chaos, local and global chaos. Entropy is an example of global chaos. Entropy is a measure of disorder and randomness like heat. But physics has long known that entropy and energy are related. The total energy of a system must include entropy. Entropy also includes information entropy. [805] Chaos theory and its relationship with quantum field theory and complexity theory will be discussed more later in the sections "The Rule of Origin Over

Chaos", "Chaos, Information, Entropy", and "From Gates to Quantum Field Theory, Complexity Theory, and Chaos" but for now allow me to interject a more philosophical perspective.

Hesiod's admonition of 'before the gods there was chaos' reminds us of information entropy. Exformation as the lack of origin, before spacetime, has a spooky, wave function relationship with all that history has brought to the fore in the small, unnoticed word '*is*'. The complexity of *phusis* gets *whitewashed* in a hegemonic context where the royal signet of Being assigns hierarchies and their 'logical nots' such as misogyny, racism, heterosexism, and gender binarism all cloaked in the unitary proclamation of equality and origin and its logical ascension to what simply is, Being. The precipice we face deconstructs the truth of modernity's '*is*' with its own classical truth value - physics, science, the thinking machine. If we can get a glimpse of what physics and science is bringing to the fore in our own, modernity's own, implosion into *phusis*, the dismantling of the thinking machine of Being will give way to a spooky radical alterity which places a demand on us in the face of the other that is not of my origin.

A Deeper Dive – Dirac and Feynman

Richard Feynman wrote in 1948 about a particular mathematical formulation sometimes called Dirac's equation named after Paul Dirac (1902-1984) used in non-relativistic quantum mechanics. Dirac's equation implied the existence of antimatter which was discovered and experimentally confirmed later. Dirac's equations give place to negative energy not only antimatter but vacuum energy, dark energy, dark matter, negative mass, and negative pressure.

> According to the theory of the Dirac sea, developed by Paul Dirac in 1930, the vacuum of space is full of negative energy. This theory was developed to explain the anomaly of

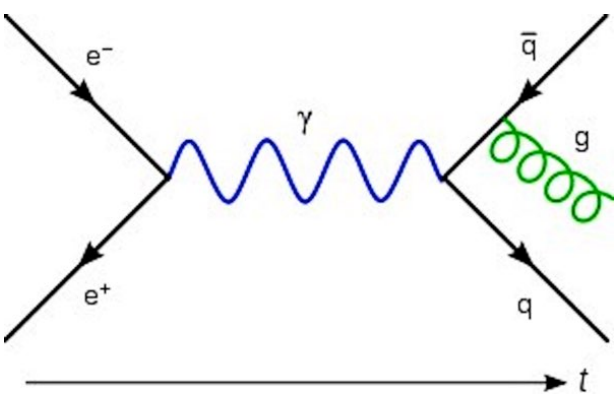
negative-energy quantum states predicted by the Dirac equation. The theory correctly predicted the existence of antimatter two years prior to the discovery of the positron in 1932 by Carl Anderson.

However the theory has since been superseded by Quantum field theory (QFT). The two theories are equivalent by means of a Bogoliubov transformation, so the Dirac sea can be viewed as an alternative formulation of quantum field theory. 806

It also gave rise to several component wave functions which embodied the theory of spin. Dirac's accomplishment is seen as one of the greatest triumphs of theoretical physics on par with Newton, Maxwell, and Einstein.

Dirac's equation is very accurate when it can be used. Rather than associating a position of a particle at a particular time, Dirac's equation associates the entire motion of the particle at a particular time.807 Dirac did this by associating four complex matrices with a particle which described the complete motion and not just a coordinate which simply described a position at a particular time. 808 Probably Dirac's great contribution was a formulation combining quantum mechanics with the theory of relativity. 809

Feynman simplified Dirac's accomplishment with his Feynman diagrams. Remember this diagram a little earlier?



Yes, a Feynman diagram. Feynman's diagrams greatly simplify complex mathematics accurately. His diagrams have found many more applications than even he was aware of, not the least of which is quantum gravity and the complex mathematics of AdS/CFT correspondence which will be discussed more later in the section entitled "The Holographic Big Bang". [811] But for now, the mathematics of AdS/CFT correspondence can be thought of like a hologram. A hologram takes an encoded lower dimensional image and when a laser light reflects off the image it decodes the information creating a higher dimensional image. The mathematics of AdS/CFT works in much the same way. However, CFT or Conformal Field Theory describes encoded quantum information in less dimensions and AdS or Anti de Sitter mathematics describes decoded higher dimensional spacetime as in general relativity (actually general relativity uses de Sitter spacetime which has one minor but important difference to be discussed later). AdS/CFT can also be used to describe the lower dimension event horizon of a blackhole and the inner volume of the volume below the event horizon which includes the singularity. Oh, and also the Big Bang.

A Deeper Dive – Phase Space

Phase space is a concept used in physics and mathematics to describe the complete set of possible states of dynamical systems. Here are the key concepts:

1. **System State:** Imagine a system, such as a collection of particles or objects. The state of this system is determined by various parameters, including positions, velocities, momenta, and other relevant variables.
2. **Coordinates:** In phase space, each of these parameters becomes a coordinate dimension. For example:

    a. If we have a single particle moving in three-dimensional space, its position and momentum determine its state. So, our phase space would have six dimensions: three dimensions for position (x, y, z) and three dimensions for momentum, p(x), p(y), p(z), meaning a dimension of momentum at the x dimension, a dimension of momentum at the y dimension, and a dimension of momentum at the z dimension.
    b. If we have multiple particles, each particle contributes its own set of coordinates to the phase space.

3. **State Representation**: Each possible state of the system corresponds to a unique point in this multi-dimensional space. So, if we know the values of all these coordinates, we can precisely describe the system's state. For example, each point in the three dimensions of space can have multiple operators which describe many kinds of behavior like momentum, energy, spin, charge, etc. for particular particles.
4. **Trajectories:** As the system evolves over time (due to forces, interactions, etc.), its state changes. This evolution traces out trajectories in phase space. These trajectories represent the system's behavior. This may also include perturbation behavior when something from the outside interferes with normally expected behavior.
5. **Visualizing Dynamics:** By plotting these trajectories, we gain insights into the system's behavior. We can see how it moves, whether it's periodic, chaotic, or stable.
6. **Applications:**

    a. **Classical Mechanics:** In classical mechanics, phase space helps us analyze the motion of particles, planets, and other physical systems, for example in terms of position and momentum.

b. **Statistical Mechanics:** In statistical mechanics, phase space is essential for understanding the behavior of large ensembles of particles (e.g., gases).
c. **Quantum Mechanics:** In quantum mechanics, we have a more abstract concept called Hilbert space, which plays a similar role. Note that in quantum mechanics, the concept of phase space is extended to include quantum states (e.g., eigenstates). However, there's an important distinction: the overall, "global" phase of a quantum state doesn't have physical meaning. Additionally, phase states break down or will not work under addition, e.g., cannot add phase states to get an overall phase state. Quantum phase space is often favored in certain contexts, such as quantum optics applications (like optical phase space) and the study of decoherence. However, in most practical situations, the formalism of quantum phase space is less commonly employed. [812]

Phase space provides a powerful framework for studying the dynamics of physical systems, allowing us to explore all possible states and their evolution.

Non-Relativistic Quantum Mechanics

Non-relativistic quantum mechanics is useful for atomic, molecular, and condensed-matter physics where electrons play an important role.[813] Mass energy also called rest mass or invariant mass is the same in all inertial frames of reference.[814] When a particle's kinetic energy is small relative to its mass energy or in other words, speeds are small in relation to the speed of light, non-relativistic quantum mechanics can be utilized.[815] In cases when the speeds of particles get close to the speed of light, relativistic mathematics can be more useful than non-relativistic mathematics. In non-relativistic

quantum mechanics time is an absolute quantity all observers and particles can agree on.[816] Relativistic mathematics gets extremely complicated. If non-relativistic quantum mechanics can be utilized, it is a very useful tool with less complexity.[817] Schrödinger's wave equation can also be more straightforward in non-relativistic quantum mechanics.[818] Much of what we have discovered from particle accelerators has provided information on non-relativistic quantum mechanics. Non-relativistic quantum mechanics is based on 'ideal' properties of elementary particles such as we see in the Standard Model. Massive amounts of observation in various environments can give a probability description with certain caveats in order to give us a Standard Model probability for particle properties. When actual values such as mass, charge, spin, etc. are dependent on observation near or at the speed of light, relativistic quantum mechanics' mathematics can be better.

Non-relativistic spacetime is any mathematical model which uses n-dimensional space and m-dimensional time as a single continuum without using the three spatial dimensions and one time dimension of relativity theory. Non-relativistic quantum mechanics can utilize classical Galileo and Newtonian spacetime. In this case, space can be Euclidian or flat geometry and the passage of time is constant. This is the commonsense notion of space and time.[819] In non-relativistic quantum mechanics special fudge factors have to be introduced to achieve greater agreement with experimental results in the Hamilton operator.[820]

A Deeper Dive – Non-Relativistic Quantum Mechanics Reformulated as Relational Quantum Mechanics

One paper[821] I found particularly interesting published in 2018 by Jianhao Yang has a different approach to non-relativistic quantum mechanics.

Non-relativistic quantum mechanics is reformulated here

based on the idea that relational properties among quantum systems, instead of the independent properties of a quantum system, are the most fundamental elements to construct quantum mechanics. This idea, combining with the emphasis that measurement of a quantum system is a bidirectional interaction process, leads to a new framework to calculate the probability of an outcome when measuring a quantum system. In this framework, the most basic variable is the relational probability amplitude. Probability is calculated as summation of weights from the alternative measurement configurations. The properties of quantum systems, such as superposition and entanglement, are manifested through the rules of counting the alternatives. Wave function and reduced density matrix are derived from the relational probability amplitude matrix. They are found to be secondary mathematical tools that equivalently describe a quantum system without explicitly calling out the reference system. Schrödinger Equation is obtained when there is no entanglement in the relational probability amplitude matrix. Feynman Path Integral is used to calculate the relational probability amplitude, and is further generalized to formulate the reduced density matrix. In essence, quantum mechanics is reformulated as a theory that describes physical systems in terms of relational properties.[822]

Non-relativistic quantum mechanics is built more on independent quantum states or independent properties of a quantum system. It is like taking a photograph which captures an instance of time. However, because different states have bidirectional interactivity this paper suggests that analyzing non-relativistic quantum mechanics would be better with relational math which describes the changes rather than the states themselves. The reason I like it is that it seems to me giving weighted values based on relationship interactions would emphasize the transitions

of states and perhaps cancels some extraneous state variables. Additionally, it has been shown that a quantum state of a subsystem is only meaningful relative to a given state of the rest of the system. Since the Schrödinger Equation is obtained when there is no entanglement in the relational probability amplitude matrix. Yet Schrödinger himself called entanglement not "***one [property of quantum mechanics] but rather the characteristic trait of quantum mechanics, the one that enforces its entire departure from classical lines of thought***". [823] Actually, entanglement measure quantifies the difference between time evolution operator of the Schrödinger Equation and the quantum measurement itself. But the probability amplitude matrix can be measured using the Feynman Path Integral. The Feynman Path Integral sums up all impacting alternatives (paths, possible results, etc.) when entanglement is involved. However, each path or process is a two-way, bidirectional process meaning one subsystem changes to another subsystem, but both change each other at the same time. This is where the unitary operator in Schrödinger's equation comes in. The unitary operator goes forwards and backwards in time so that both the bi-directional changes can be accounted for. Let me give an example.

Boy state interacts with girl state. Classically in this interaction boy state results in girl state. However, with no entanglement as in a pure state, quantum mechanics' boy state's interaction with girl state causes boy state to be boy/girl state and simultaneously, girl state to be girl/boy state. When we add in entanglement it gets much more complicated. When entanglement is involved, we can have multiple bidirectional states. This means simultaneously boy state's interaction with girl state causes boy state to be boy/girl, girl/boy, boy/not girl, not boy/girl, along with many or perhaps infinite environmental variations of boy/x-girl, y-boy/x-girl, z-boy/ x-girl etc. Likewise, simultaneously girl state's interaction with boy state causes girl state to be girl/boy state boy/girl state, girl/not boy state, not girl/boy state, along with many or perhaps infinite environmental variations of girl/x-boy, y-girl/x-boy, z-girl/xx-boy

etc. This is why it is called quantum physics. The bidirectional effect of unitarity reversibility need not be temporal. It could also be other quantum properties like spin, charge, etc. This implies that unitarity in the reversibility is not really temporal in the way we think of 'temporal'. It is really the way quantum states are bidirectional affecting each other simultaneously.

With that being the case, Yang's relational quantum mechanics is not so much different math as it's a different way to approach non-relativistic quantum mechanics. Yang writes, "*Quantum mechanics is a theory about the physical description of physical system relative to other systems, and this is a* ***complete*** *description of the world.*" 824 We tend to think of completeness for example as having two completely independent states of a quantum subsystem, allowing them to interact, and then determining what the completely independent state of both subsystems might be. But that idea is fundamentally wrong in quantum mechanics. Complete states are more of a misnomer than an accurate description. There are no completely determined independent states in quantum mechanics. Completeness is defined relationally not independently. I will come back to this much later in a philosophical sense in the section entitled, "The Radical Alterity of the Other".

Relativistic Quantum Mechanics

Relativistic quantum mechanics is applied with special relativity when the speeds of particles get closer to the speed of light or, in other words, when a particle's kinetic energy is large relative to its mass energy. Relativistic quantum mechanics is applied with special relativity. Originally Schrödinger and Heisenberg were formulations in non-relativistic philosophy. However, relativistic quantum mechanics works with Klien-Gordon and Dirac's path-integral formalism which also work with special relativity.

Relativistic quantum mechanics (RQM) is quantum

> mechanics applied with special relativity. Although the earlier formulations, like the Schrödinger picture and Heisenberg picture were originally formulated in a non-relativistic background, a few of them (e.g. the Dirac or path-integral formalism) also work with special relativity. [825]

Unique features which separate relativistic quantum mechanics from non-relativistic quantum mechanics are the prediction of antimatter, spin magnetic moments of elementary spin 1/2 fermions, fine structure, and quantum dynamics of charged particles in electromagnetic fields. While relativistic quantum mechanics is more complicated than non-relativistic quantum mechanics, it is more accurate. Non-relativistic quantum mechanics has to fudge certain values to agree with experimental evidence.

> Key features common to all RQMs include: the prediction of antimatter, spin magnetic moments of elementary spin 1/2 fermions, fine structure, and quantum dynamics of charged particles in electromagnetic fields.[6] The key result is the Dirac equation, from which these predictions emerge automatically. By contrast, in non-relativistic quantum mechanics, terms have to be introduced artificially into the Hamiltonian operator to achieve agreement with experimental observations.[826]

Quantum Field Theory

There is a relativistic quantum mechanics applied with special relativity called quantum field theory (QFT). However, one very important tenet of relativity is that in all reference frames, it works the same (i.e., with the same laws of physics). The ability of relativity to work the same in all reference frames is called relativistic invariance. Relativistic invariance is not true of non-relativistic quantum mechanics. Quantum field theory has the same

problem where relativistic invariance does not work in relativistic quantum mechanics. This is why quantum field theory has tried to address the problem of relativistic invariance.[827] Quantum field theories like thermodynamics and entropy work in infinite degrees of freedom mathematically speaking. Another way of thinking this is like entropy where we do not need to, nor can we know, every detail about how it works as in knowing all the chaotic information it contains, but we can gather certain ideas about the limitations of the system (i.e., its potential for useful information). In this way quantum field theory is highly abstract but can yield useful results. Entanglement applies as *the characteristic trait of quantum mechanics*, but there are unentangled particles. In the case of one unentangled particle, it can be explainable as consistent with locality, as existing in a definite point in space, and find agreement with special relativity as a field theory.[828]

> It is important to note that quantum field theory (QFT) is not inclusive of the quantum wave function. Problems of entangled particles, locality, uncertainty, in regard to observational disruptions of the wave function cannot be addressed by a 'real' field theory as in electrodynamics or electromagnetic fields. Quantum mechanics (QM) describes ideal pure states and mixed states which have probabilistic assignments and does not deal with how these states transition in fields but uses an operator function that approximates particular observables in relativistic quantum mechanics – a sort of fudge which has more limited or constrained usefulness. The quote below may be a little confusing but the gist of it is the wave function of for example position and time, $\psi(x,t)$, has operators for example position and time that can be applied to the wave function, $\phi(x,t)$ which affects or operates on the pure or mixed states. The operators actually allow predictions for such phenomenon as space and time.

It is important to realize that the operator valued field $\phi(x,t)$ in QFT is not analogous to the wavefunction $\psi(x,t)$ in QM, i.e., the quantum mechanical state in its position representation. While the wavefunction in QM is acted upon by observables/operators, in QFT it is the (operator valued) field itself which acts on the space of states. In a certain sense the single particle wave functions have been transformed, via their reinterpretation as operator valued quantum fields, into observables. This step is sometimes called 'second quantization' because the single particle wave equations in relativistic QM already came about by a quantization procedure, e.g., in the case of the Klein-Gordon equation by replacing position and momentum by the corresponding quantum mechanical operators. Afterwards the solutions to these single particle wave equations, which are states in relativistic QM, are considered as classical fields, which can be subjected to the canonical quantization procedure of QFT. The term 'second quantization' has often been criticized partly because it blurs the important fact that the single particle wave function ϕ in relativistic QM and the operator valued quantum field ϕ are fundamentally different kinds of entities despite their connection in the context of discovery.

In conclusion, it must be emphasized that both in QM and QFT states and observables are equally important. However, to some extent their roles are switched. While states in QM can have a concrete spatio-temporal meaning in terms of probabilities for position measurements, in QFT states are abstract entities and it is the quantum field operators that seem to allow for a spatio-temporal interpretation. See the section on the field interpretation of QFT for a critical discussion.[829]

The "Stanford Encyclopedia of Philosophy" started out its

section entitled “Quantum Field Theory” like this,

> In contrast to many other physical theories there is no canonical definition of what QFT is. Instead one can formulate a number of totally different explications, all of which have their merits and limits. One reason for this diversity is the fact that QFT has grown successively in a very complex way. Another reason is that the interpretation of QFT is particularly obscure, so that even the spectrum of options is not clear. Possibly the best and most comprehensive understanding of QFT is gained by dwelling on its relation to other physical theories, foremost with respect to QM, but also with respect to classical electrodynamics, Special Relativity Theory (SRT) and Solid State Physics or more generally Statistical Physics. However, the connection between QFT and these theories is also complex and cannot be neatly described step by step.[830]

The success and vast utility of quantum field theory came with its elegant integration with special relativity. Relativistic quantum mechanics takes the Standard Model of elementary particles and integrates them as field quanta. In other words, the particles have a field like quality because of the way they flow like waves to and from zero-point energy transitioning as quarks and leptons. Visualize all these elementary particles as wave patterns which perpetually fluctuate from non-existence through patterns of waves like quarks and leptons into a pattern, we call an electron and back into elementary particle-patterns or waves back into the oblivion of zero-point energy.[831] Relativistic quantum mechanics (RQM) has been amazingly successful using quantum field theory.

> The most successful (and most widely used) RQM is relativistic quantum field theory (QFT), in which elementary particles are interpreted as field quanta. A unique

consequence of QFT that has been tested against other RQMs is the failure of conservation of particle number, for example in matter creation and annihilation.[832]

Since quantum mechanics (QM) deals with the wave function, it describes a particle or a very small group of particles. Quantum field theory (QFT) deals with particles as fields. It can be utilized to describe how large systems of particles behave. Quantum field theory works well with relativistic, general relativity. Quantum mechanics, the behavior of particular particles works well with quantum field theory.

If one thinks of QM as the modern theory of one particle (or, perhaps, very few particles), one can then think of QFT as an extension of QM for the analysis of systems with many particles—and therefore with a large number of degrees of freedom. In this respect going from QM to QFT is not inevitable but rather beneficial for pragmatic reasons… Thus the transition from QM to QFT allows treatment of both particles and fields within a uniform theoretical framework.

(As an aside, focusing on the number of particles, or degrees of freedom respectively, explains why the famous renormalization group methods can be applied in QFT as well as in Statistical Physics. The reason is simply that both disciplines study systems with a large or an infinite number of degrees of freedom, either because one deals with fields, as does QFT, or because one studies the thermodynamic limit, a very useful artifice in Statistical Physics.)

Moreover, issues regarding the number of particles under consideration yield yet another reason why we need to extend QM. Neither QM nor its immediate relativistic extension with the Klein-Gordon and Dirac equations can describe systems with a variable number of particles. However, obviously this is essential for a theory that is

supposed to describe scattering processes, where particles of one kind are destroyed while others are created.[833]

So, how do we bridge quantum field theory (QFT) which can play on a relativistic, general relativity of spacetime with quantum mechanics (QM).

Minkowski's spacetime mathematics in the late 19th century was very important to Einstein but like QM it did not explain how spacetime fields and gravity interacted. This was the piece that Einstein's general relativity in 1915 explained.

In Einstein's theory of special relativity, time was unified with space to form a four-dimensional spacetime. But this "Minkowski spacetime" still constitutes an absolute background in the sense that there is no reaction of fields and matter – Minkowski spacetime provides only the rigid stage for their dynamics. Einstein considered this lack of back reaction as very unnatural.

Minkowski spacetime provides the background for relativistic quantum field theory and the Standard Model of particle physics. In the non-relativistic limit, it yields quantum mechanics with its absolute, Newtonian time t. This is clearly seen in the Schrödinger equation,

$$\mathrm{i}\hbar\frac{\partial\psi}{\partial t} = \hat{H}\psi$$

The time-dependent Schrödinger equation shown above shows how the change in the wave function, ψ, over time times the reduced Planck constant is related to a spacetime field of momenta or various values of momentum. Here is a longer explanation of the formula above. This is the time-dependent Schrödinger equation where 'H' is the Hamiltonian of the system (the energy operator) and 'ℏ' is the reduced Planck constant ($\hbar = h / 2\pi$ with h as the Planck constant, allowing conversion from energy to frequency units). [835] Minkowski space is the background, empty space of relativity. It has no object, mass, or particles in it. It is what we always think of as the four dimensions of spacetime. Four-dimensional space can be rotated using something called the Lorentz transformation around a Hamilton axis. This is complex vector mathematics, but the basic idea is that using the Lorentz Transformation of Minkowski spacetime we can replace velocities in a spacetime field with momenta or momentums in a spacetime field. The result of this is that from a momenta field energy can be calculated. Hamilton mechanics is highly associated with geometry (think of spacetime curvature). It also provides a link between classical mechanics and quantum mechanics. [836]

All the above discussion is to say that Einstein's spacetime is not a force called gravity but fundamentally geometry plain and simply. Additionally, geometry is dynamic, not absolute and static. This geometry is shaped like waves on an ocean by matter and fields and even its own geometry. Think about it like this, waves and tides, the geometry of the ocean, interacts with itself as the additive and subtractive motions of the waves (wavicles of particles), momentum of waves colliding (transient mass and energy), foaming, raising and lowering its base level with tides (base energy levels) is simply geometry perpetually modifying itself.

> But the story is not yet complete. It was Einstein's great insight to see that gravity is a manifestation of the geometry of spacetime; in fact, gravity is geometry. This led him to his

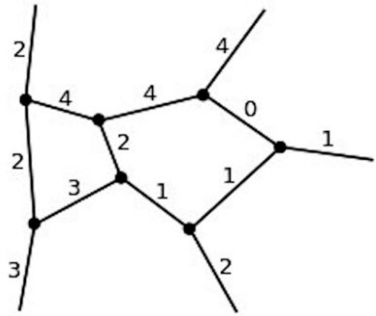
> general theory of relativity, which he completed in 1915. Because of this identification, spacetime is no longer absolute, but dynamical. There is now a reaction of all matter and fields onto spacetime and even an interaction of spacetime with itself (as is e.g. the case in the dynamics of gravitational waves). [837]

We saw from the time-dependent Schrödinger equation above that we measure all of this geometric dynamism with our classical clock, the steady tick of 'now' moments. This does not mean that quanta have an absolute sense of time but that we use time to measure how the wave function evolves. From our relative perspective the speed of light is 186,000 miles per second but if it were possible to travel at the speed of light there would be no tick of time. Time dilation simply means our 'absolute time' is not absolute but changes relative to the speed of light. In quantum field theory, the concept of time is a bit different from classical physics. According to the problem of time, there is a conceptual conflict between general relativity and quantum mechanics in that quantum mechanics proper there is no derivation of temporality. But quantum mechanics employs the classical view of time pragmatically in experiments and the quantum wave function as the flow of time, as universal and absolute. The wave function itself is not temporal. It is simultaneous meaning all possibilities at once. However, for us to make sense of state transitions in state reduction, collapse, or branching we need to assign a unitary operator to it for the time-dependent wave equation. Whereas general relativity regards the flow of time as malleable and relative. In the context of quantum field theory, time is usually considered in the presence of the background Minkowski geometry, which gives you a unique notion of time (and thus, unitarity). However, there have been formulations of quantum field theory that are independent of time, such as in quantum cosmology. [838]

Loop Quantum Gravity

Loop quantum gravity is a theory of quantum gravity that attempts to develop a quantum theory of gravity based directly on Albert Einstein's geometric formulation rather than the treatment of gravity as a mysterious mechanism (force). Loop quantum gravity is a theory of quantum gravity which tries to merge quantum mechanics and general relativity. However, each of the approaches is very different. Relativity assumes space time has a smooth continuous background. Loop quantum gravity breaks the fabric of spacetime up into chunks. In effect, loop quantum gravity tries to bring gravity, spacetime geometry, into quantum mechanics. The way it does this is by taking the Standard Model of Elementary Particles into a geometric case inclusive of quantum gravity. Instead of looking at spacetime curvature as some kind of result of matter, of elementary point particles, loop quantum gravity attempts to found gravity on geometry, the wave-like phenomena of quanta. In this way both Einstein's general relativity and loop quantum gravity have a common basis in geometry. But they have very different geometries at work.

Loop quantum gravity postulates that the structure of space and time is composed of finite loops woven into an extremely fine fabric or network. Loop quantum gravity tells us that space is composed of chunks of highly entangled quanta which are Planck-scale volumes 10^{-99} cm^3 called nodes or vertices where three-dimensional space exists. The nodes are connected at their boundaries with three lines called worldlines.



Two-dimensional spin network diagram, after Penrose[839]

The worldlines are made up of a single elementary particle or a compound of elementary particles which have angular momentum.[840] Each worldline has a discrete spin value. A network with a spin number of zero has zero probability of occurring. There are rules for calculating spin value and probabilities of occurring. It is interesting to note that quantum spin, angular momentum, is quantized as h/2 where 'h' is the Planck constant. For fermions such as electrons and quarks, the spin number must always be odd. For bosons such as photons and gluons, the spin number will always be even. The spin number times h/2 is the angular momentum.[841] Three worldlines join at each node.[842] The nodes and links form networks like Tinker toys. These networks are called spin networks.

Roger Penrose is credited with the discovery of spin networks in 1971. The nodes themselves have no direction of time. Spin networks of spin nodes define a three-dimensional hypersurface or curved surface of space. Nodes and links can be added and subtracted like soap bubbles. The network dynamism is called spin foam. The evolution of spin networks comprised of spin foam, has a scale above the order of a Planck length, approximately 10^{-35} meters, and smaller scales are meaningless. Consequently, not just matter, but space itself emerges from elementary wavicles. The change of spin foam is the emergence of one-dimensional time. Together, the three-dimensional hypersurfaces of spin networks and

one-dimensional spin foam changes make up four-dimensional spacetime. This makes loop quantum gravity compatible with Einstein's general relativity. However, instead of Einstein's smooth, continuous transitions of spacetime, loop quantum gravity is composed of chunky, discrete particles. Yet again, we see complementarity of wave and particle.

> Developed in the 1990s by Smolin and Rovelli, among others, LQG [Large Hadron Collider] proposes that space consists of objects called nodes that have Planck-scale volumes of 10-99 cm3 — the smallest scale that physics can account for. These nodes define where three-dimensional space exists. The nodes are connected to each other by links, like a set of Tinkertoys. Networks of these nodes and links are called spin networks. But spin networks can be altered in sequences that add and subtract links and nodes. These changes form a 4-dimensional network called a spin foam. (For more on string theory and LQG [Loop Quantum Gravity], see "Imagining our infant universe" in the April 2022 issue.) [843]

Research in loop quantum gravity has evolved in two directions: the more traditional canonical loop quantum gravity, and the newer covariant loop quantum gravity, called spin foam theory. The most well-developed theory that has been advanced as a direct result of loop quantum gravity is called loop quantum cosmology. Loop quantum cosmology advances the study of the early universe, incorporating the concept of the Big Bang into the broader theory of the Big Bounce, which envisions the Big Bang as the beginning of a period of expansion that follows a period of contraction, which has been described as the Big Crunch. [844] Since loop quantum gravity's intention is to show how quanta gives rise to the relativity of spacetime, its mathematics is very different from general relativity.

Loop quantum gravity is not classical meaning it is based in

quantum wave functions. Just as in quantum field theory, there is a classical limit or branch from the observer effect into classicism, which explains how classic general relativity works.

> The Classical limit is the ability of a physical theory to approximate classical mechanics. It is used with physical theories that predict non-classical behavior. Any candidate theory of quantum gravity must be able to reproduce Einstein's theory of general relativity as a classical limit of a quantum theory. This is not guaranteed because of a feature of quantum field theories which is that they have different sectors, these are analogous to the different phases that come about in the thermodynamical limit of statistical systems. Just as different phases are physically different, so are different sectors of a quantum field theory. It may turn out that loop quantum gravity belongs to an unphysical sector – one in which one does not recover general relativity in the semiclassical limit or there might not be any physical sector. 845

The Mathematics of Loop Quantum Gravity

Much of the mathematics of loop quantum gravity depends on quantum field theory. First, let's take a look at some terms used in loop quantum gravity. In mathematics, topology has to do with shapes. Topology is concerned with the properties of a geometric object that are preserved under continuous deformations, such as stretching, twisting, crumpling, and bending; that is, without closing holes, opening holes, tearing, gluing, or passing through itself. 846 Einstein's relativity beautifully shows how geometric shapes of spacetime (topologies) can change dynamically e.g., due to the speed of light. A fully developed quantum theory of gravity should be able to explain how topologies, geometric shapes of spacetime, can dynamically change. A few topologies in loop

quantum gravity have fixed topologies which means they cannot change dynamically. A homeomorphism means similar shapes. If similar geometric shapes can be mathematically mapped forward and backward continuously to achieve both shapes, this is called isomorphism. A diffeomorphism is an isomorphism of smooth manifolds. It is an invertible function that maps one differentiable manifold to another such that both the function and its inverse are continuously differentiable. The diagram below shows an example of what this mathematics does. Click on the image if it does not change.

847

Note: If the animation does not work click on the link in the footnote.

Loop quantum gravity is formally background independent, meaning the equations of loop quantum gravity are not embedded in, or dependent on, space and time (except for its invariant topology). Instead, they are expected to give rise to space and time at distances which are 10 times the Planck length. The issue of background independence in loop quantum gravity still has some unresolved subtleties. For example, some derivations require a fixed choice of the topology, while any consistent quantum theory of gravity should include topology change as a dynamical process.

Space-time as a "container" over which physics takes place has no objective physical meaning and instead the

gravitational interaction is represented as just one of the fields forming the world. This is known as the relationalist interpretation of space-time. In loop quantum gravity this aspect of general relativity is taken seriously and this symmetry is preserved by requiring that the physical states remain invariant under the generators of diffeomorphisms. The interpretation of this condition is well understood for purely spatial diffeomorphisms. However, the understanding of diffeomorphisms involving time (the Hamiltonian constraint) is more subtle because it is related to dynamics and the so-called "problem of time" in general relativity. A generally accepted calculational framework to account for this constraint has yet to be found. A plausible candidate for the quantum Hamiltonian constraint is the operator introduced by Thiemann. 848

Problems with Loop Quantum Gravity

The time problem in loop quantum gravity is a concept that arises from the need to reconcile the principles of quantum mechanics with those of general relativity. In loop quantum gravity, space and time are quantized, meaning that they are broken down into discrete units. However, this leads to a problem: the theory does not have a well-defined notion of time. The problem of time in quantum gravity occurs because time is taken to have a different meaning in each of general relativity and ordinary quantum theory. One of the remarkable aspects of loop quantum gravity is that it appears to eliminate time entirely. Carlo Rovelli, a physicist and one of the founders of loop quantum gravity, discusses the role(s) that space and time play in loop quantum gravity and the version of these notions required to make sense of a quantum gravitational world in his paper. 849

Here are some other problems which remain for loop quantum gravity,

- Can quantum mechanics and general relativity be realized as a fully consistent theory (perhaps as a quantum field theory)?
- Is spacetime fundamentally continuous or discrete?
- Would a consistent theory involve a force mediated by a hypothetical graviton, or be a product of a discrete structure of spacetime itself (as in loop quantum gravity)?
- Are there deviations from the predictions of general relativity at very small or very large scales or in other extreme circumstances that flow from a quantum gravity theory? 850

Additionally, loop quantum gravity has no operator (or function) to deal with infinitesimal varying geometric shapes as quanta is not continuous like general relativity. This also causes problems with closing shapes which are in general relativity closed geometries. There are problems at time reconciling discrete shapes of quanta with continuous shapes of general relativity. Transitioning into a classic general relativity from the quantum wave equations can have issues at times. Observables or measurements in general relativity spacetime can be problematic due to non-linearities in loop quantum gravity. However, these problems have been addressed in more recent research. 851

Problems with String Theory: The Landscape and Predictability

While String Theory is mathematically elegant, it faces significant hurdles. Chief among them is the 'Landscape Problem.' The theory allows for approximately 10^{500} different solutions (or different ways to curl up those extra dimensions), each resulting in a universe with different physical laws. String Theory struggles to explain why *our* specific universe, with our specific electron mass and gravity, is the one that exists. Critics argue that if a theory can predict everything, it effectively predicts nothing. Furthermore,

despite decades of effort, the theory has yet to produce a unique, testable prediction—such as the discovery of supersymmetric particles—that would distinguish it from the Standard Model.

The Crystallizing Block Universe

There is another way which I find very interesting that was devised for thinking about the time problem.

> Physicist George Ellis of the University of Cape Town in South Africa and Tony Rothman of Princeton University offered an interesting combination of the ideas in 2009. They called it the Crystallizing Block Universe: The past of the current moment is fixed and stored via memories and records — in some cases, literally etched in stone. The future of the current moment is a cloud of probabilities that is determined by the laws of quantum mechanics. What we call the present is the boundary between these two regimes, where the indeterminacy of the future is crystallizing into the certainty of the past. Humans ride this boundary of crystallization through their perception of their individual nows. [852]

Physicist George Ellis and Tony Rothman advocate an evolving block universe or a crystallizing block universe. Let's remember that with the four-dimensional block universe time.

> Of course, scientists want to understand how we experience time in mathematical terms that can be tested through experiments. In relativity, the three dimensions of physical space are combined with the one dimension of time into a four-dimensional space-time. The basic elements of space-time are events and worldlines. Events are points within four-dimensional space-time at which some physical interaction or phenomenon takes place, such as two particles

colliding or a particle emitting a photon. Worldlines are the paths objects trace through space-time along a sequence of events.

Mathematically, we work with space-time as a four-dimensional continuum: Between any two four-dimensional points, there are an infinite number of additional points. This is a convenient approximation, but it does not represent physical space-time. There are not an infinite number of real, physical events, and so most of the mathematical points are devoid of anything physical.

This means that what we call 3D space is an illusion filled with ghostly, empty points that are not connected to anything in our real world. Einstein expressed this idea when he said, "Time and space are modes in which we think and not conditions in which we live." [853]

Like the three spatial dimensions where we can go from any point in space to another point in space, the dimension of time in Einstein's block universe is completely reversible and non-existent, at least in the way we experience time. The evolving block universe has the arrow of time like what we experience where time is irreversible. The future, like the quantum wave, remains open where all possibilities occur simultaneously as in superposition. But the observer effect branching into classical temporality has a kind of binding effect as what philosophy would articulate as 'coming into presence'.

…the concept of a Crystallizing Block Universe (CBU), which reflects the quantum transition from indeterminacy to certainty, while nevertheless resembling the Evolving Block Universe (EBU) on large enough scales. The CBU is a representation of the effects of "quantum weirdness" where "the present" is effectively the transition region in which quantum uncertainty changes to classical definiteness. The

> fundamental issue then arises as to how the effective times at different scales mesh together, leading to the concept of global and local times. 854

In the quote above, the branching of the quantum wave function "reflects the quantum transition from indeterminacy to certainty" needs a little clarification of how I understand it. The transition from indeterminacy, even more what I refer to as chaos, is from quantum physics nomenclature 'probability' meaning not certain at all. However, 'certainty comes from the classical narrative, our common sense, which we believe has the flavor of certainty.

So, the past has a crystalizing effect as it has been set into the backdrop of previous observer effects. This is a moving dynamic boundary as each fall into the present crystalizes the past and has a kind of binding effect on the future observer effects which do not exist as they are in superposition. As has been discussed, the historic abstractions of absolute time as sequential 'now' moments and absolute space as linear extension built into objective physics and common sense is a narrative which takes us away from our lived experience of time. What we actually experience is lived feelings, events, sensations, and relationships which make up our idea of temporal histories.

Additionally, I find the idea of evolving, crystalizing global and local lived experiences carries with it a kind of historic community where multiplicitous branching or falls into classicism became bound together as communal, collective narratives we think of as common sense. It also allows for what we think as human pathologies and even widely variant perceptions of animals, plants, and perhaps even geologies as the effects need not be what we conceive of as 'conscious/consciouses', as 'internal to the self/ common narratives' but they could also retain what we think of as 'external/purely reactive to environmental conditions as erosion, volcanos, earthquakes, nebulas, etc. The arrow of time for the crystalizing block universe is entropy.

> Our world features an arrow of time where entropy increases with time. This accords with our sense of time as a one-way street, from past order to future disorder. Yet, there is no basis for the arrow of time in microscopic physics — the realm of quantum mechanics. Those equations are just as valid when time runs in reverse. Therefore, some scientists think the arrow of time exists because the universe must have started out in an incredibly orderly and unlikely state. This is called the Past Hypothesis. [855]

Even our memory as constantly being neurologically torn down and rebuilt, re-narrated, can be explained in terms of entropy.

> But why do we remember the past and not the future? The reason for this asymmetry has to do with entropy — the amount of disorder in the universe. We have memories and historical records only because entropy in the past was lower than the entropy of the present. [856]

and existent as our lived time stretching from a past to a future. For the evolving block universe, the past, wave function collapse or the current moment is crystalized, etched in stone, fixed as memories, narrations, fossils, and records. The future is the province of quantum uncertainty, probability, the quantum wave function. As a single human and plural humans, we ride an ever-evolving boundary of what physics might call ‘now’ moment or phenomenology would call lived time and lived space. In any case this is called the worldline in the evolving block universe. The past block universe has worldlines which are not encoded in our worldlines, in my worldlines. This is reminiscent of branching with the quantum wave function. This encoded past information is like the two-dimensional encoded information in the surface boundary of the hologram. As humans are historical beings, we have access to the past, encoded/exformation of a branching, informational

updating, wave function. But our perceptual three-dimensional 'memory' is superimposed with temporality, an ever-evolving narrative of the past moving towards a future. Phenomenology thinks of this as lived space and time. Each branch, informational update, is forever lost as my moving worldline embodied as our worldlines. As entangled, encoded branching there is no retention of history's imagined objective past. The past is a necessarily neurological, re-narrated hermeneutic of wave function collapse. More importantly, in this narrativizing there is an arrow of time from branching, a basis for causality in the crystallizing block universe. By 'crystallizing block universe' we are not referring to some kind of absolute, deterministic, record of the universe as purely objective. Worldlines are not purely 'subjective' either. Let's not forget the observer effect, superposition, branching information of the quantum wave function which has a spooky way of incorporating neurological, sociological, and historical narratives. I will address the philosophical issue posed here at the end of this section. 857

The Quantum Gravity Problem

At the current time, here is the main problem with quantum gravity – time.858 Let's take a step back and look at some of the cosmological history of time.

We know from general relativity that the speed of light is highly correlated with spacetime. At the moment of the Big Bang, there was no time or space. Our cosmological observations tell us that as we look further into space we see further back in time. They also tell us that by extrapolating back in time we get back to singularity. From the description above in the cosmology section, photons during inflation could not move freely in the opaque universe. As far as we know the universal constants were the same from the beginning of the Big Bang. If the universal constant '*c*', the speed of light, was valid during the electroweak era of inflation, either it

must have been exceeded or the universal constant '*c*' did not exist. A very famous physicist told us in 1968,

> One field of work in which there has been too much speculation is cosmology. There are very few hard facts to go on, but theoretical workers have been busy constructing various models for the universe, based on any assumptions that they fancy. These models are probably all wrong. It is usually assumed that the laws of nature have always been the same as they are now. There is no justification for this. The laws may be changing, and in particular quantities which are considered to be constants of nature may be varying with cosmological time. Such variations would completely upset the model makers.[859]

This quote by Dirac is at the beginning of Joao Magueijo paper entitled "New varying speed of light theories". The idea that universal constants could have varied over time from the Big Bang is highly controversial but has been debated in cosmology especially with the notion of cosmic inflation which appears to be the most viable candidate for the behavior of the very early universe. Quantum theory as it now exists assumes time. Additionally, quantum theory assumes time as rigid and discontinuous, not bendy as in Einstein's relativity as spacetime. Furthermore, time is reversible for relativity. A mathematician named Marvin Minkowski in the late 1800s actually came up with the idea of four-dimensional spacetime.

> A great mathematician, Hermann Minkowski, who had been Einstein's professor at the Zurich Polytechnic, understood that time must be considered a fourth dimension of the same quality as the three spatial dimensions, with the difference that must be regarded mathematically as an imaginary dimension, and can therefore be represented geometrically

> with a coordinate similar to the other three spatial coordinates.[860]

Einstein was influenced by Minkowski's math, but he thought it had a problem because it did not account for gravity.

> At a time when Minkowski was giving the geometrical interpretation of special relativity by extending the Euclidean three-space to a quasi-Euclidean four-space that included time, Einstein was already aware that this is not valid, because it excludes the phenomenon of gravitation. He was still far from the study of curvilinear coordinates and Riemannian geometry, and the heavy mathematical apparatus entailed.[861]

I will discuss this more later, but special relativity assumes a flat mathematical space utilizing Minkowski space. General relativity uses a generalization of Minkowski space called a Lorentzian manifold which allows for more dimensions than four (one of time and three of space). This allows for curved mathematical space and spacetime geometry in which curved spacetime produces what we call gravity. However, the added dimensions beyond four (three for space and one for time) are needed to explain how the speed of light contorts spacetime geometry. In this way, relativity's geometry can be smooth and contiguous but also, highly abstract. By abstract, I mean it does not focus on the smallest details of spacetime itself but on the macro-overall effect of whatever the smallest details are. Both special relativity and general relativity schemes give us a block universe where there is no arrow of time, the kind of time we experience. The block universe is sometimes called eternalism because it is static.

Both Einstein's and Minkowski's block universe have the same result for time – the block universe. Einstein's relativity tells us time is dynamic. Time is relative to the observer or more precisely the

chosen inertial frame. Time is simply already given in Einstein's spacetime. Because time is simply given, we can abstractly visualize and mathematically depict this as the 'block universe'. We can conceptually utilize the notion of four-dimensional spacetime blocks to illustrate various regions of spacetime. The block universe of spacetime in essence takes time as an illusion.

Space and time as past, present, and future are all accounted for in relativity's four dimensions.

> Minkowski's space–time … provided support for viewing the universe as a four-dimensional space–time block that exists as one entity. In this view, called the block universe (or eternalism in philosophical discussions), there is no basis for singling out a present time that separates the past from the future because all times coexist with equal status. As such, it has profound implications for how we view our experience of existing in the present moment, able to reflect on the past and plan new actions in a variable future. Indeed, if all times coexist with equal status, the future is as fixed as the past and so humans can only act in compliance with the future; this directly conflicts with the notion that humans can act freely. 862

Not long before his death Einstein famously described the distinction between past, present, and future as a 'stubbornly persistent illusion,' reflecting the Block Universe implication of General Relativity where all moments exist simultaneously in the spacetime manifold.

The real problem with Einstein's block universe is that there is no preference for this moment over any other moment, going forward or backward in time is irrelevant and symmetric. However, if that is true, there is no arrow of time, why does entropy only increase in one direction in our universe, going forward, and not backward? Even at the moment of Big Bang the universe had

minimum entropy, maximum density, and minimum complexity. Entropy and complexity have increased ever since and, as the universe expands, density has decreased.[863] If there was no spacetime curvature, no gravity, nothing would have mass. This would mean everything, if there were anything, would travel at the speed of light. This would not be our universe. Relativity tells us that the speed of light twists and distorts spacetime itself so that inertial mass can exist.

So far, we know that there are two massless elementary particles, the photon and the gluon. However, the gluon cannot be seen directly as free particles because it is always confined within hadrons. There are two other unconfirmed massless particles, the Weyl fermion and possibly the graviton. Massless particles are of a very different kind than particles with mass. As I mentioned earlier photons do not 'see' the universe at all. From the perspective of a photon, the universe does not exist. For the photon, the universe is an infinitesimal instant. But when we look at photons, we see them being curved by spacetime, large mass objects, sucked into blackholes, and popping in and out of existence in zero-point energy as they traverse through the universe. From our relativistic perspective as existence, photons are elementary particles. We understand them as traveling through 'time' not as entirely oblivious to spacetime geometry, the universe. The two different perspectives are absolutely different. Yet, we have seen this before. We call this complementarity. A massless particle is very bizarre. It does not fit into our logic. We assume that it must be one or the other. The fact is that it is both non-existent and existent. It is abstract and concrete. In relativity it is 'relative to our reference frame'. In quantum mechanics, it is both geometry (abstract) and entanglement (spooky existence). Could it be that time is both existent and non-existent, abstract and concrete? But how does time happen on a quantum level?

In fact, time is a big problem in quantum physics. In quantum physics I have discussed the problem of entanglement and space.

Entangled particles do not recognize any such thing as commonsense tells us about space and yet spacetime is emergent from exformation. It is not known if time is quantized as spacetime curvature would be in the case of gravitons. If time is quantized, it would be at the Planck level or about 10^{-43} seconds. A hypothetical quantum of time has been called a chronon, but no evidence has been able to show that it exists.[864]

While Einstein's relativity is reversible, quantum theory tells us that time is irreversible. Time does not work if quantum interactions are played backwards.

> A particle maintains simultaneous quantum states until you measure it, at which point the particle adopts one of the states. Mysteriously, individual measurement outcomes are random and unpredictable, even as particle behavior collectively follows statistical patterns. This apparent inconsistency between the nature of time in quantum mechanics and the way it functions in relativity has created uncertainty and confusion.[865]

Ellis and Rothman's idea has some relevance to loop quantum gravity and worldlines. However, these worldlines in loop quantum gravity are not simply universal as in our classical understanding of absolute time progressing from a past to a future. There is a sense in phenomenology that classical time is a historical abstraction which has been handed down to us as absolute time vis a vis our phenomenological lived ability as historical beings. The narrative of history which makes our present world possible and practical is not necessarily how we concretely live time. Time drags on in boredom where the future evades us or time hurrying to the next moment when we are having a great time. However, there is something very special about the concrete way we live time which the abstract, equal-segmented, linear time does not capture. Interesting enough, the mere fact that we can have an abstraction of time as equal-

segmented, linear time we deem as ‘reality’ tells us there is something very special about the kinds of beings we are as historical beings. But perhaps there is more to the story. Let’s start by looking at the quantum wave function.

In 1926 Schrödinger introduced the first wave function. He devised the wave function to describe microscopic particles which acted like waves.

> The wave function is the most fundamental concept of quantum mechanics. It was first introduced into the theory by analogy,[866] the behavior of microscopic particles like a wave, and thus a wave function is used to describe them. Schrödinger originally regarded the wave function as a description of real physical wave. But this view met serious objections and was soon replaced by Born’s probability interpretation, which becomes the standard interpretation of the wave function today.[867]

Due to serious objections in the physics establishment, it was replaced with the Born probability equation in the same year. This is the standard equation which has remained to the present day. This equation can give a probable amplitude location where a particle might be found. The drawback to this equation was cumbersome to theorists as it relied on measurement.

> According to this interpretation, the wave function is a probability amplitude, and the square of its absolute value represents the probability density for a particle to be measured in certain locations. However, the standard interpretation is still unsatisfying when applying to a fundamental theory because of resorting to measurement.[868] In view of this problem, some alternative realistic interpretations of the wave function have been proposed and widely studied.[869]

The further interpretations cited above either deal with a field equation or a point equation. In a field, time is taken to be simultaneous for a charged quantum system. In a particle, time is measured sequentially as the particle is in one location at each instance.[870] However, neither of these instances add up to a derivation of time of how time arises in *phusis*, in quanta.

For quantum physics there is no time before a measurement is taken. I prefer to describe this as chaos over superposition. My choice of chaos over superposition is to drive home the point that 'reality' is not 'real' in the way that history has passively handed over to us and we have simply assumed to be the case. Perhaps it would be better to think of chaos as all possible information without the ordering of cause and effect, spacetime, or a higher order which unifies and is accessible through logic as histories reduction of *logos*. In quantum wave functions we have all known possibilities or better indetermination given by superposition. When we observe quanta experimentally, we collapse the indetermination of the wave function, and we are left with a more or less probable state. In the sense of a probable state, time could be taken as an absolute, as the instantaneous now moment. We could piece together instantaneous now moments and get a probability distribution.

Quantum mechanics, where entanglement is *the characteristic trait of quantum mechanics*, has forms like quantum field theory and relativistic quantum mechanics which incorporate time but cannot explain how time evolves from quantum entanglement. Even in relativistic quantum mechanics and quantum field theory, time is not reversible. When the quantum waveform collapses or information is updated, it cannot be undone. The initial possible states of the wave function are lost forever as soon as it is observed, it is time irreversible.

Entanglement is a collapse of superposition updating information. We can think of this as the loop quantum gravity's worldline ever updating information upon observation. In 2013 a

physicist named Ekaterina Moreva showed that if you use two entangled photons, one photon as a time clock or time reference to observe the entangled partner, the system appears to evolve in time. However, this time only applies to the observer while the rest of the universe remains static. The important point here is that there is no outside to the entangled observer where any such thing as time exists.

According to Stephen Hawking, James Hartle, and Alexander Vilenkin, the singularity of the Big Bang had many dimensions. However, at the moment of the Big Bang quantum mechanical tunneling triggered eternal inflation. At this one moment, one dimension emerged as the direction of the past to the future. This started increasing entropy, decreasing density, and increasing complexity from the singularity. This then would be that arrow of time.[871]

All these theories utilize time without giving us a notion of how time, for example, may arise from particle interaction or from wave dynamics. Another problem with particle physics is how to explain gravity. But gravity is a shorthand way of thinking curved spacetime. Curved spacetime is addressed by loop quantum gravity and also the block universe which assumes time but cannot derive time.

So, if we take time out of the picture, we know that relativity tells us space and time are the same, then we must take space out as well. This creates what philosophers call an ontological problem or problem of exactly what existence could mean without space and time. So, the quantum gravity problem inherently has a basic problem with time and how such a thing as quantum gravity theory can exist in time. Yet, we know it must exist from the previous discussion and entropy, density, and complexity. Gravitons are an interesting idea explaining gravity. If gravity can be explained in terms of quantum theory and we know that space and time have a kind of complementarity, that may be a vehicle to explain time. The root of the problem is how to quantize spacetime when gravitons

are taken as an instant of time and not a flow of time.

> ….Though quantum gravity has been the subject of investigation by physicists for almost a century, philosophers have only just begun to investigate its philosophical implications.
>
> …Whereas research in particle physics proceeds in large part by examining the data collected in large particle accelerators, which are able to smash particles together at sufficiently high energies to probe the properties of atomic nuclei in the fallout, gravity is so weak that there is no physically realistic way to do a comparable experiment that would reveal properties at the energy scales at which quantum gravitational effects are expected to be important—it would take a particle accelerator of galactic size to even approach the required energies.
>
> …the problem is roughly that in quantizing the structure of spacetime itself, the notion of a quantum state, representing the structure of spacetime at some instant, and the notion of the evolution of the state, do not get any traction, since there are no real "instants".[872]

This is how quantum theory necessitates philosophy. Since philosophy has always addressed the notion of origin, it also must reckon with quantum gravity. Both physics and philosophy must come together by necessity in quantum gravity theory. The purpose of this book is to explore how this could possibly happen and what the implications are for both physics and philosophy.

The Philosophical Implications of Worldlines

Our habitual orientation of historic assumptions makes us think that either something is subjective or objective. While this has the 'ring of truth' for us, *phusis* has an alien ring to this acclamation. Why?

Because there is no distinctive and clear distinction which can be made between subject and object for the quantum wave function. There are no binary dualisms, no symmetries, no clear or absolute boundaries without collapse or branching of superposition which imposes narration on everything and anything we ever know from birth to death. Yet, there is an exterior we do not know. We make up objectivity as 'what it is'. Remember the event horizon of our expanding universe, the black/white hole, the boat/ocean analogy? Whatever is not in our light cone is not existent, has no causal reality in the way we think cause and effect. Some of us as a collectivity have light cones which give us a similar understanding of what we call 'reality'. Certainly, hard facts like fossils and records etched in a past which no longer exist and fall into the causal set we think together as 'reality'. 'Reality' can have different tones and timbres like 'theys' and non-binary gender associations. Diversity has always been a part of human anthropology. It is a strength which makes us better. However, there are some of us that live outside or on the edge of these boundaries. This can be due to biological differences with cause pathologies of perception like autism or splinters of interpretive pathologies like criminal behavior, flat-earthers, and even inhuman murderous monsters. None of these boundaries are clear or set in stone. Binary thinking where it is either us or them has no 'them'. It only has an idea, a narrative, of what 'them' is. Caving into 'my narration' is echoing myself. It is thinking everything is the same as my collapse of superposition. This is ultimately falling into narcissism, solipsism, the absolute certainty that 'I' am all there is and there is no other god beside me. When religion loses the ethic toward alterity, it simply becomes the religion of 'me'. I believe this was the original sin of Lucifer in Judaism, Islam, and Christianity. It is simply called pride. *Phusis* is telling us now to listen, to look at the alterity of quantum entanglement and geometry, chaos and order, existence and non-existence, and the ethics of complementarity.

Loop Quantum Gravity Problems

Loop quantum gravity has its problems. The devil is in the details here. Many complications and difficulties would have to be addressed to make loop quantum gravity viable for many physicists. Lorentz invariance has the same reasoning in quantum physics as in general relativity where the laws of physics must work the same for all reference frames. If *phusis* works differently depending on where you are in spacetime, this goes against much of currently established quantum physics. If violations of sameness, e.g., laws of physics, are allowed how could we call the Standard Model of Elementary Particles standard?

Yet, on the other hand we know that dark matter and dark energy at the least pose a question to established laws of invariance. Furthermore, entanglement is firmly established, and its informational content is not consistent with cause and effect or spacetime. What is more, blackhole singularity is also a violation of laws of physics from an existential, ontological footing. I have already discussed symmetry and symmetry breaking and the spooky violations of the quantum wave function. Discontinuities are the rule rather than the exception in quantum field theory and quantum physics in general. However, with all its difficulties, the current state of quantum physics has a very firm footing in existential or ontological problems. While we cannot rule out the Lorentz invariance, we can at least know that a lot of hard work remains for physicists. There is an old saying that laws were made to be broken as in putting tree of the knowledge of good and evil in the middle of Eden's Garden and the divine prohibition against eating of the fruit thereof.[873]

Some of the criticisms of loop quantum gravity, including the quote below, are that the spin network and spin foam are localized meaning they refer back to spacetime as geometrically localized just as general relativity does. In other words, the background of spacetime is a mesh of local geometries. Remember that for relativity spacetime is invariant. This means all the laws of physics

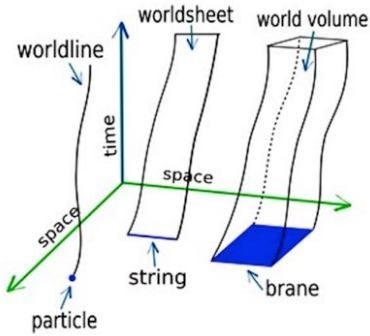
are the same for a specific reference frame. This is how the classical physics of Newton, of absolute time and space, eloquently becomes a limited case of relativity (e.g., where the speed of light is not a factor). Below is a more technical description of the problems with loop quantum gravity which poses assumed locality on spacetime.

> For numerous reasons, loop quantum gravity has problems with consistency (and ability to produce any large, nearly smooth space at all), but even if it implied the semi-realistic picture of gravity we hear in the most favorable appraisals by its champions, it has many properties that make it incompatible with the Standard Model, for example its Lorentz symmetry violation. This is a serious problem because the terms of the Standard Model are those terms that are renormalizable, Lorentz-invariant, and gauge-invariant. The Lorentz breaking imposed upon us by loop quantum gravity would force us to relax the requirement of the Lorentz invariance for the Standard Model terms as well, so we would have to deal with a much broader theory containing many other terms, not just the Lorentz-invariant ones, and it would simply not be the Standard Model anymore (and if would be infinitely underdetermined, too).
>
> And even if these incompatible properties weren't there, adding up several disconnected Lagrangians just isn't a unified theory of anything.
>
> Two paragraphs above, the incompatibility was presented from the Standard Model's viewpoint – the addition of the dynamical geometry described by loop quantum gravity destroys some important properties of the quantum field theory which prevents us from constructing it. But we may also describe the incompatibility from the – far less reliable – viewpoint of loop quantum gravity. In loop quantum gravity, one describes the spacetime geometry in terms of some other variables you wrote down and one may derive that the areas

> etc. are effectively quantized so the space – geometrical quantities describing it – are "localized" in some regions of the space (the spin network, spin foam, etc.). This really means that the metric tensor that is needed to write the kinetic and other terms in the Standard Model is singular almost everywhere and can't be differentiated. The Standard Model does depend on the continuous character of the spacetime which loop quantum gravity claims to be violated in Nature. So even if we're neutral about the question whether the space is continuous to allow us to talk about all the derivatives etc., it's true that the two frameworks require contradictory answers to this question.[874]

The answer loop quantum gravity advocates tell us is that spacetime locality is not assumed by spin networks and spin foam. Both loop quantum gravity and string theory oppose each other but perhaps in a complimentary fashion. String theory proposes that elementary particles are not point-like but in our spacetime one-dimensional extended objects or strings. However, in string theory strings are ten-dimensional or more. The effect of this is that strings are dual dimensional depending on existence (concrete) or non-existence (abstraction).

Strings can be open or closed. Because the energy of strings is so small, towards the Planck size, we cannot see the spatial expansion of the string. What we can see experimentally is the point-like characteristic common to our Standard Model of Elementary Particles making string theory highly compatible with existing quantum physics. A typical string size would be about 10^{-33} cm. Strings vibrate and oscillate. Different oscillation modes account for different kinds of established elementary particles or what is referred to as Lorentz quantum numbers. As a string evolves in time its sweeping oscillations create a two-dimensional sheet called a worldsheet. World lines, worldsheets, and world volumes, are derived from particles, strings, and branes as shown below.



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Worldsheets are a result of temporalizing spin foam from worldlines in loop quantum gravity.[876] A closed string sweeps out a two-dimensional area or sheet with no boundaries. So closed strings have no boundary or are infinite. Open strings sweep out a two-dimensional area or sheet with boundaries and are finite. In the former case we have non-locality. In the latter case we have locality. Due to this two-dimensional geometric description worldsheets are abstract. However, this abstract worldsheet is embedded in spacetime.[877] The downside of string theory is that there is not enough Planck scale or low energy physics to tell us how this geometric abstraction gets enacted as background independent. In other words, how does the rubber meet the road in string theory?

When a system, moving object, or process deviates from its normal state or path by some outside influence, this behavior is called perturbation. Elementary particles as point-like have odd behaviors which string theory describe very beautifully as a geometry of different string types. More importantly, gravity is made congruent with other elementary particles as simply another excitation of a string. Note again that we have concrete existence, point-like particles, and non-existence, geometric abstractions, working in a complementary fashion.

The main merits of string theory are

its elegant unification of different theories used in known fundamental physics,

its well-defined perturbation expansion, expected to be finite order-by-order, and

its theoretical and mathematical richness and complexity.[878]

Quantum field theory relies on a perturbation scheme where *phusis* can go spooky in the night or away from the conventional ideas of trying to recover a local homogeneity at the limits of infinity. This means that in theory and hope there are no odd behaviors which cannot be recovered from localities steeped in infinities. However, the actual way quantum field theory goes about this is with perturbative or non-local theories to explain the expansion of spacetime. The bottom line is physics is still mired with non-local and local theories of spacetime no matter which way we go. Even more, gravity seems to have a propensity in physics for non-locality. General relativity tells us that there is no classical Newtonian background space, e.g., absolute time and space but that all spacetime is relative to the speed of light. Spacetime bends to accommodate the speed of light. But relativity thinks of gravity simply as a given of spacetime curvature and not how this comes about on the smallest scales. The smallest Planck scales are the domain of:

- Loop quantum gravity is classically, in terms of general relativity, background-dependent (gravitational field locality), non-perturbative (no funny business), and generally covariant (works well with relativity).
- Quantum field theory is classically, in terms of general relativity, non-background dependent (gravitational field non-local), perturbative (funny business), and generally non-covariant (does not work well with relativity)

- String theory beautifully explains using abstract geometry how to explain elementary particles mathematically but has problems in how that translates to where the rubber meets the road in terms of experimental particle physics or how strings actually get manifested in Planck sized physics since strings are way too small to measure. String theory is classically, in terms of general relativity, non-background dependent (gravitational field non-local), perturbative (funny business), and generally non-covariant (does not work well with relativity). 879

The reason why loop quantum gravity and other such approaches are around in the first place is due to the inability of physics to explain gravity and its odd atemporal behavior. This problem is sufficiently severe enough that it invites major revisions to established quantum physics. This is why quantum gravity has become as popular as it is among physicists. The agreement of the Standard Model of Elementary Particles and quantum field theory (QFT) is an inherent strength in quantum mechanics (QM). QFT is not a specific theory but a framework for multiple theories like quantum chromodynamics (QCD) or quantum electrodynamics (QED) which are well established in the history of physics. Novel theories which do not break established norms are preferred over more disruptive theories. However, we know that whatever causes spacetime curvature or gravity is so extremely small, at the Planck level, that discoveries at most will be indirect. And since general relativity (GRT) and special relativity (SRT) are so successful the preferred approach is toward modifying quantum field theory so that it fits more eloquently with general relativity. However, the non-locality of gravity stubbornly refuses a localized box.

> The “standard model of elementary particle physics” is sometimes used almost synonymously with QFT. However, there is a crucial difference. While the standard model is a

theory with a fixed ontology (understood in a prephilosophical sense), i.e., three fundamental forces and a certain number of elementary particles, QFT is rather a frame, the applicability of which is open. Thus, while quantum chromodynamics (or 'QED') is a part of the standard model, it is an instance of a quantum field theory, or short "a quantum field theory" and not a part of QFT. This section deals with only some particularly important proposals that go beyond the standard model, but which do not necessarily break up the basic framework of QFT…

The standard model of particle physics covers the electromagnetic, the weak and the strong interaction. However, the fourth fundamental force in nature, gravitation, has defied quantization so far. Although numerous attempts have been made in the last 80 years, and in particular very recently, there is no commonly accepted solution up to the present day. One basic problem is that the mass, length, and time scales quantum gravity theories are dealing with are so extremely small that it is almost impossible to test the different proposals.

The most important extant versions of quantum gravity theories are canonical quantum gravity, loop theory and string theory. Canonical quantum gravity approaches leave the basic structure of QFT untouched and just extend the realm of QFT by quantizing gravity. Other approaches try to reconcile quantum theory and general relativity theory not by supplementing the reach of QFT but rather by changing QFT itself. String theory, for instance, proposes a completely new view concerning the most fundamental building blocks: It does not merely incorporate gravitation but it formulates a new theory that describes all four interactions in a unified way, namely in terms of strings. [880]

This difference with gravity has been addressed with interesting

ideas of spacetime emergence from encoded exformation. Quantum entanglement is firmly established and even the basis of quantum computing which will bring major impacts to humanity and is well into development. This will be discussed later. The philosophical problem is that entanglement and quantum wave observer effects are highly problematic for philosophical ontology, the study of existence or Being, and epistemology, how we know that we know, and more importantly, the historic footings of these philosophies in plain ol' common sense. But for physicists the weight of evidence does not have to bear the load of history requiring history, thought, and language to adapt. Gravity is the proverbial fly in the ointment for physics.

> While quantum gravity theories are very complicated and even more remote from classical thinking than QM, SRT and GRT, it is not so difficult to see why gravitation is far more difficult to deal with than the other three forces. Electromagnetic, weak and strong force all act in a given space-time. In contrast, gravitation is, according to GRT, not an interaction that takes place in time, but gravitational forces are identified with the curvature of space-time itself. Thus quantizing gravitation could amount to quantizing space-time, and it is not at all clear what that could mean. One controversial proposal is to deprive space-time of its fundamental status by showing how it "emerges " in some non-spatio-temporal theory. The "emergence" of space-time then means that there are certain derived terms in the new theory that have some formal features commonly associated with space-time. See Kiefer (2007) for physical details, Rickles (2008) for an accessible and conceptually reflected introduction to quantum gravity and Wüthrich (2005) for a philosophical evaluation of the alleged need to quantize the gravitational field. Also, see the entry on quantum gravity.[881]

String theory goes a long way to finding a pathway between quantum field theory and relativity. String theory does this by adding geometric dimensions which we already know cannot be avoided from quantum field theory while still eloquently reducing to findings of general relativity (GRT) and special relativity (SRT).

> String theory is one of the most promising candidates for bridging the gap between QFT and general relativity theory by supplying a unified theory of all natural forces, including gravitation. The basic idea of string theory is not to take particles as fundamental objects but strings that are very small but extended in one dimension. This assumption has the pivotal consequence that strings interact on an extended distance and not at a point. This difference between string theory and standard QFT is essential because it is the reason why string theory also encompasses the gravitational force which is very difficult to deal with in the framework of QFT. [882]

The issue with quantum field theory (QFT), the infinities which present problems to re-normalization, and string theory (ST), simplifying string theory to experimentally usable formulations of particle behavior, has to do with Planck-sized dimensions and impracticalities of experimental verification. Gravity is at the vanishing point of the infinites of quantum field theory.

> It is so hard to reconcile gravitation with QFT because the typical length scale of the gravitational force is very small, namely at Planck scale, so that the quantum field theoretical assumption of point-like interaction leads to untreatable infinities. To put it another way, gravitation becomes significant (in particular in comparison to strong interaction) exactly where QFT is most severely endangered by infinite quantities. The extended interaction of strings brings it about

that such infinities can be avoided. In contrast to the entities in standard quantum physics strings are not characterized by quantum numbers but only by their geometrical and dynamical properties. Nevertheless, “macroscopically” strings look like quantum particles with quantum numbers. A basic geometrical distinction is the one between open strings, i.e., strings with two ends, and closed strings which are like bracelets. The central dynamical property of strings is their mode of excitation, i.e., how they vibrate.

Reservations about string theory are mostly due to the lack of testability since it seems that there are no empirical consequences which could be tested by the methods which are, at least up to now, available to us. The reason for this “problem” is that the length scale of strings is in the average the same as the one of quantum gravity, namely the Planck length of approximately 10^{-33} centimeters which lies far beyond the accessibility of feasible particle experiments. But there are also other peculiar features of string theory which might be hard to swallow. One of them is the fact that preferred models of string theory need space-time with 10, 11 or even 26 dimensions. In order to explain the appearance of only four space-time dimensions string theory assumes that the other dimensions are somehow folded away or “compactified” so that they are no longer visible. An intuitive idea can be gained by thinking of a macaroni which is a tube, i.e., a two-dimensional piece of pasta rolled together, but which looks from the distance like a one-dimensional string.

Due to the problems of string theory, many physicists have abandoned it, but not all. Some think that, among the numerous alternative proposals for reconciling quantum physics and general relativity theory, string theory is still the best candidate, with “loop quantum gravity” as its strongest rival (see the entry on quantum gravity). Correspondingly,

string theory has also received some attention within the philosophy of physics community in recent years. Probably the first philosophical investigation of string theory is Weingard (2001) in Callender & Huggett (2001), an anthology with further related articles. Dawid (2003) (see Other Internet Resources below) argues that string theory has significant consequences for the philosophical debate about realism, namely that it speaks against the plausibility of anti-realistic positions. Also see Dawid (2009). Johansson and Matsubara (2011) assess string theory from various different methodological perspectives, reaching conclusions in disagreement with Dawid (2009). Standard introductory monographs on string theory are Polchinski (2000) and Kaku (1999). Greene (1999) is a very successful popular introduction. An interactive website with a nice elementary introduction is 'Stringtheory.com' (see the Other Internet Resources section below).[883]

The Philosophical Time Problem

Both Einstein's relativity and quantum gravity have a time problem. This problem has always been around. Here is a brief history of time.

Before Newton, and thus before the advent of modern science, time was associated with periodic motion, notably the motion of the 'Heavens'. It was therefore a countable time, each tick corresponding to one period; there was no idea of a continuum.

It was Newton's great achievement to invent the notion of an absolute and continuous time. Such a concept was needed for the formulation of his laws of mechanics and universal gravitation. Although Newton's concepts of absolute space and absolute time were heavily criticized by some

> contemporaries as being unobservable, alternative relational formulations were only constructed after the advent of general relativity in the 20th century.[884]

Yet, after the 20th century physics, we have been left with a gaping hole which cannot be separated from philosophy as well. How can we find any basis in physics for time?

> Any theory of quantum gravity has to deal with the inherent incompatibilities of quantum theory and relativity, not the least of which is the so-called "problem of time" – that time is taken to have a different meaning in quantum mechanics and general relativity. This is perhaps best exemplified by the Wheeler-DeWitt equation, devised by John Wheeler and Bruce DeWitt back in the 1970s. Their attempt to unify relativity and quantum mechanics resulted in time essentially disappearing completely from their equations, suggesting that time does not exist at all and that, at its most fundamental level, the universe is timeless. In response to the Wheeler-DeWitt equation, some have concluded that time is a kind of fictitious variable in physics, and that we are perhaps confusing the measurement of different physical variables with the actual existence of something we call time.[885]

Mathematics in physics has a way of reconciling incompatibilities between relativity, the very large, and quantum theory, the very small, using complex variables. Even singularities can be resolved mathematically using complex variables. But complex variables do not solve existential or ontological problems, meaning how to prove time really exists. Complex variables only kick the can down the road so to speak. However, when we think about waves and fluid dynamics where a confluence of waves causes constructive or destructive overall effects on the amplitude

of a wave, complex numbers provide a simpler solution to finding the resulting amplitude of the wave. Complex variables are made up of two parts: a real value part and an imaginary value part. The imaginary part is indicated as the square root of minus one which is mathematically impossible. However, one very important use of an imaginary number is in calculating probability or superposition. Even though the square root of a negative number is undefined, just like dividing by zero, squaring the square root of negative one is a positive number.

In many areas of physics imaginary numbers are a convenience to eliminate more complex real number mathematics. However, there are many cases where real number solutions which increase mathematical complexity can be used. Think of the previous example of waves which are not so unlike wavicles in particle physics. If you knew every amplitude of every wave at a specific time, you could just add them up to get the resultant wave. However, this does not work in quantum mechanics. All attempts to find a mathematics of quantum mechanics that can be based on real values, explicitly known, have come up short. Moreover, thanks to the work of John Bell and many others, quantum mechanics has emphatically proven that imaginary numbers are indispensable.

John Bell among others have proven that there are no local hidden variables (or waves equivalent to water waves) which one day will be discovered to eliminate the need for complex variables.[886] The natural question of how can this be proved since you cannot prove a negative? John Bell discovered that you could prove a negative if the extremes are large enough. The short of it is, classic mechanics tells us that everything has some effect on something else. However, entangled particles or systems have been proven to not affect each other through real, physical means like waves in the ocean. The process of entanglement cannot find objectivity in some medium, for example, like local variables. Uncertainty will never be bridged by certainty. Observers and interacters including me, entangled systems, and experimental

setup, will always affect what is seen or perceived AND without any justifiable notion of time which can mediate this impasse. Ocean waves have a medium of time and space. Not so with the spooky behavior of quantum physics.

All this leads to two issues at the philosophical heart of the time problem in my opinion:

1. The epistemological problem
2. The ontological problem [887]

The epistemological problem asks how do we know that we know? For classical physics including Newton, the answer fundamentally boiled down to God. Time and space are absolutely determinate and infinite.

> Isaac Newton formulated his ideas on space and the universe during his early years at Cambridge in response to René Descartes's 1644 publication Principles of Philosophy. Sometime between 1666 and 1668, in an unpublished manuscript that we refer to by its opening words, De gravitatione, Newton wrote that an “infinite and eternal” divine power coexists with space, which “extends infinitely in all directions” and “is eternal in duration.” Descartes claimed that where there is no matter there can be no space; on the contrary, argued Newton, space, by virtue of omnipresent spirit, exists where there is no matter. Descartes claimed that matter extends indefinitely; on the contrary, argued Newton, God has created in infinite space a material system of finite extent.[888]

For Einstein we see a much more complex picture of his epistemology. He seems at times as a certain kind of pragmatist, “a type of unscrupulous opportunist”. He seems like a realist seeking an ‘objective’ world apart from mere perception. He seems like an

idealist of an odd sort with anthropological ideas not based on empirical observation. He seems like a positivist in valuing logic based on sensation. He seems like a Platonist or Pythagorean establishing knowledge on logical simplicity.

> ”The reciprocal relationship of epistemology and science is of a noteworthy kind. They are dependent upon each other. Epistemology without contact with science becomes an empty scheme. Science without epistemology is – insofar as it is thinkable at all - primitive and muddled. However, no sooner has the epistemologist, who is seeking a clear system, fought his way through to such a system, than he is inclined to interpret the thought-content of science in the sense of his system and to reject whatever does not fit into his system. The scientist, however, cannot afford to carry his striving for epistemological systematics that far. He accepts gratefully the epistemological conceptual analysis; but the external conditions, which are set for him by the facts of experience, do not permit him to let himself be too much restricted in the construction of his conceptual world by the adherence to an epistemological system. He therefore must appear to the systematic epistemologist as a type of unscrupulous opportunist: he appears as realist insofar as he seeks to describe a world independent of the acts of perception; as idealist insofar as he looks upon the concepts and theories as the free inventions of the human spirit (not logically derivable from what is empirically given); as positivist insofar as he considers his concepts and theories justified only to the extent to which they furnish a logical representation of relations among sensory experiences. He may even appear as Platonist or Pythagorean insofar as he considers the viewpoint of logical simplicity as an indispensable and effective tool of his research.”[889]

Einstein, Podolsky, and Rosen published a paper in 1935, the EPR paper, entitled, "Can Quantum Mechanical Description of Physical Reality Be Considered Complete?" I will discuss this in more detail later in this book. In this paper Einstein wanted to question the current state of quantum mechanics as being incomplete. He tells us that there must be an explanation for quantum entanglement which can be explained in terms of local, hidden variables. This idea exhibits a bit of a more classical notion of determinism. That is, reality is locally based on hidden variables which we simply have not discovered yet. Note that George Berkeley was an 18th century idealist philosopher who believed that everything we perceive is ideas. Einstein is reported to have said,

> The entire alleged difficulty proceeds from the fact that one postulates something not observed as 'real' (this is the answer of the quantum theorist). What I dislike in this kind of argumentation is the basic positivistic attitude, which from my point of view is untenable, and which seems to me to come to the same thing as Berkeleys principle, *esse est percipi* [essence is perception or to be is to be perceived]. Being is always something which is mentally constructed by us, that is, something which we freely posit (in the logical sense). The justification of such constructs does not lie in their derivation from what is given by the senses. Such a type of derivation (in the sense of logical deducibility) is nowhere to be had, not even in the domain of pre-scientific thinking. The justification of the constructs, which represent reality for us, lies alone in their quality of making intelligible what is sensorily given (the vague character of this expression is here forced upon me by my striving for brevity)."[890]

The classic notion of reality cannot comprehend space as fundamentally non-deterministic. Quantum mechanics plays loose with the idea of an underlying reality which philosophers call

ontology or the study of being. Quantum mechanics was born in a time starting in the 19th century and continuing in the 20th century where metaphysics had exhausted itself in favor of the scientific method and logic. Einstein and Niels Bohr had life-long debates on quantum mechanics. For Bohr, quantum mechanics should remain strictly in the domain of observation and measurement. Bohr believed that any findings in quantum mechanics would ultimately result in confirming the limited case of classic physics' cause and effect. In Bohr's Como lecture in 1927, Bohr wrote of a complementary rule which would reenforce classic physics,

> Bohr pointed to two sets of descriptions which he took to be complementary. On the one hand, there are those that attribute either kinematic or dynamic properties to the atom; that is, "spacetime descriptions" are complementary to "claims of causality", where Bohr interpreted the causal claims in physics in terms of the conservation of energy and momentum. On the other hand, there are those descriptions that ascribe either wave or particle properties to a single object. How these two kinds of complementary sets of descriptions are related is something Bohr never indicated. [891]

However, less than ten years after his Como lecture Bohr tacitly abandoned "wave-particle complementarity" in favor of the exclusivity of "kinematic-dynamic complementarity". [892] This Cambridge paper ask the question about Bohr's "kinematic-dynamic complementarity",

> What, then, is Bohr's argument?
>
> The mutual exclusiveness of kinematic and dynamic properties
>
> Kinematic and dynamic attributes in quantum mechanics are mutually exclusive in the sense that they cannot be

simultaneously measured; they are, in this sense, epistemically incompatible. Why did Bohr think this? His reasons may seem intricate, but they are basically quite simple. Two main factors, he maintains, account for the epistemic incompatibility:

(a) measurements of these two different sorts of properties require mutually exclusive experimental arrangements, incompatible measurement procedures;

(b) the indeterminability [sic] of the interaction between the object and the instrument of measurement precludes extrapolation of the different measurement results to one and the same time.[893]

Later in 1938 Bohr authored a paper entitled, “The Causality Problem in Atomic Physics.” Here is what he said,

Indeed, as adequate as the quantum postulates are in the phenomenological description of the atomic reactions, as indispensable are the basic concepts of mechanics and electrodynamics for the specification of atomic structures and for the definition of fundamental properties of the agencies with which they react. Far from being a temporary compromise in this dilemma, the recourse to essentially statistical considerations is our only conceivable means of arriving at a generalization of the customary way of description sufficiently wide to account for the features of individuality expressed by the quantum postulates and reducing to classical theory in the limiting case where all actions involved in the analysis of the phenomena are large compared with a single quantum. In the search for the formulation of such a generalization, our only guide has just been the so called correspondence argument, which gives expression for the exigency of upholding the use of classical concepts to the largest possible extent compatible with the

quantum postulates.[894]

In the paper quoted above Bohr spoke of quantum theory as reducing to a limiting case of classical physics. The limiting case would assume that "*all actions involved in the analysis of the phenomena are large compared with a single quantum*." Bohr's correspondence rule would ultimately confirm the metaphysics of classic physics predeterminations of 'reality' vis-à-vis "*the basic concepts of mechanics and electrodynamics for the specification of atomic structures and for the definition of fundamental properties of the agencies with which they react*". After Einstein's 1935 EPR paper, the Stanford article tells us Bohr said,

> After the EPR paper he stated quite clearly: "the whole situation in atomic physics deprives of all meaning such inherent attributes as the idealization of classical physics would ascribe to such objects."[895]

Since Einstein and Bohr, we have had much more solid evidence that both of their realist and positivistic, epistemological, and ontological underpinnings about reality have succumbed to their most unsettled ramifications of the new science of quantum physics.

> From the birth of the theory of quantum mechanics in 1925/6 to the outbreak of war in Europe, a clear orthodoxy emerged in the conceptual and ontological framework for understanding quantum theory. Now known as the Copenhagen interpretation, this framework embodied the positivistic tendencies of Heisenberg and Bohr, and was set opposed to the more realist tendencies of de Broglie, Einstein, and Schrödinger. It was not until Bell's theorem in the 1960s, and its experimental tests in the 1970s and 1980s, that new energy was breathed into this interpretational debate. However, beginning in the mid-1940s, the first

> suggestions of retrocausality as part of the conceptual and ontological framework in quantum theory had already materialized.[896]

In this quote from Einstein, he seems to indicate a more empiricist view in that the final determination of reality is experimental observation while making fun of the positivists.

> ....that which appears to me to be the programmatic aim of all physics: the complete description of any (real) situation (as it supposedly exists independently of any act of observation or substantiation). Whenever the positivistically inclined modern physicist hears such a formulation, his reaction is that of a pitying smile. He say to himself: "there we have the naked formulation of a metaphysical prejudice, empty of content, a prejudice, moreover, the conquest of which constitutes the major epistemological achievement of physicists within the last quarter century. Has any man ever perceived a 'real physical situation'? How is it possible that a reasonable person could today still believe that he can refute our essential knowledge and understanding by drawing up such a bloodless ghost?"[897]

There seems to be a little bit of tongue in check in the previous statement. Einstein could not get philosophically comfortable with the current state of quantum physics which he contributed immensely. His slap at the positivist philosopher's disdain for the metaphysics of 'reality' shows us something important about the historic background of the 19th and early 20th centuries. The historic setting of Einstein and Bohr was preceded by August Comte's positivism where metaphysics is overcome, Berkley's absolute idealism where pure immanence is sensation and Hegel's idealism as more correctly the unfolding of immanence into Concept. Through the 19th century classic metaphysics had played

itself out in favor of science and logic. This was not some sort of empiricism. Let's take a look at Hegel's treatment of immanence as a case in point of this. In Hegel's writing in the 19th century and the Young Hegelians or Left-Hegelians which followed Hegel by a decade or so, we see Hegel's dialectics as the process of sublation (German: *aufhebung*). The second movement of Hegel's "Encyclopedia of Logic" tells us,

> The second moment—the "dialectical" (EL §§79, 81) or "negatively rational" (EL §79) moment—is the moment of instability. In this moment, a one-sidedness or restrictedness (EL Remark to §81) in the determination from the moment of understanding comes to the fore, and the determination that was fixed in the first moment passes into its opposite (EL §81). Hegel describes this process as a process of "self-sublation" (EL §81). The English verb "to sublate" translates Hegel's technical use of the German verb aufheben, which is a crucial concept in his dialectical method. Hegel says that aufheben has a doubled meaning: it means both to cancel (or negate) and to preserve at the same time (PhG §113; SL-M 107; SL-dG 81–2; cf. EL the Addition to §95). The moment of understanding sublates itself because its own character or nature—its one-sidedness or restrictedness—destabilizes its definition and leads it to pass into its opposite. The dialectical moment thus involves a process of self-sublation, or a process in which the determination from the moment of understanding sublates itself, or both cancels and preserves itself, as it pushes on to or passes into its opposite.[898]

For Hegel, from sublation we have an immanence which does not arise from some metaphysical assumption but purely from the ideas themselves.

> …the form or determination that arises is the result of the

> self-sublation of the determination from the moment of understanding, there is no need for some new idea to show up from the outside. Instead, the transition to the new determination or form is necessitated by earlier moments and hence grows out of the process itself. Unlike in Plato's arbitrary dialectics, then—which must wait around until some other idea comes in from the outside—in Hegel's dialectics "nothing extraneous is introduced", as he says. His dialectics is driven by the nature, immanence or "inwardness" of its own content. As he puts it, dialectics is "the principle through which alone immanent coherence and necessity enter into the content of science".[899]

For Einstein, Bohr, Heisenberg, and Schrödinger, the worst accusation which could be leveled against them would be to call them a metaphysician of 'reality'. Neither could they comfortably find a sublation as for example, some unified field theory. All of them were fully aware of the problematic, severely unreconcilable, findings of quantum physics. They all understood that the dual and difficult implications of the wave-particle double-slit experiment put them on one hand treacherous advocates of metaphysical, reactionary 'realists' which hung on to the scientific, institutional conservatism of their day and on the other hand their own inabilities to satisfy their classical physics training with the quizzical findings of their own research. I am not going to go through later scientific and philosophical break-throughs since the early to mid-19th century except to say that it now appears their ambivalences now appear to have been resolved in a way that 1) shows their historic reluctance to come to grips with the implications of their own findings and 2) confirms their own apprehensions about their cataclysmic findings.

Both general relativity and loop quantum gravity have geometry in common. Relativity tells us spacetime and gravity are the same physical phenomenon. But they both come at it from two

fundamentally different perspectives. First a manifold is a background, a setting, like zero-point, vacuum energy. A metric is an additional structure that is imposed on the background or the manifold.[900] Think of a manifold as a background and a metric as a foreground.

Relativity tells us that the gravitational field is a manifold, a background, upon which a spacetime metric, a foreground, is imposed.

Loop quantum gravity tells us as well that the gravitational field is a manifold, a background, upon which a quantum metric, a foreground, is imposed.

But quantum field theory tells us that the quantum field is the manifold, the background, not the gravitational field. When the quantum field is taken as the background of spacetime it does not cohabitate well with spacetime locality or another way of thinking this is that quantum field theory is perturbative. And quantum gravity and strings are also perturbative meaning that they do not conform to the normal way spacetime is conceived in general relativity. The quote below is difficult to understand but the gist of it in the way I understand is that quantum field theory and quantum gravity have a non-locality about them which violates causality and assumptions made in general relativity about the background setting of the gravitational field – how gravity bends spacetime. This is a counter point to non-locality in quantum field theory and most string theory. However, the author does maintain that loop quantum gravity maintains a local background in agreement with the gravitational field of general relativity. I have inserted some of my comments in brackets to try to clarify the difference between metric and manifold.

> The main idea behind loop quantum gravity is that one takes general relativity seriously. General relativity is the discovery that the spacetime metric [foreground] and the gravitational field [background] are the same physical entity. A quantum

theory of the gravitational field is therefore also a quantum theory of the spacetime metric [foreground]. It follows that quantum gravity cannot be formulated as a quantum field theory over a metric manifold [foreground of a background], because there is no (classical) metric manifold [foreground of a background] whatsoever in a regime in which gravity (and therefore the metric [background]) is a quantum variable.

One can conventionally split the spacetime metric [foreground] into two terms, consider one of the two terms a background that gives a metric [foreground] structure to spacetime and treat the other as the quantum field. This is the procedure on which perturbative [deviating from the gravitation field of general relativity] quantum gravity, perturbative [deviating from the gravitation field of general relativity] strings, as well as several current nonperturbative [conforming to the gravitation field of general relativity] string theories, are based. In this framework one assumes that the causal structure of spacetime is determined by the underlying background metric [foreground] alone, and not by the full metric [foreground of spacetime]. Contrary to this, loop quantum gravity assumes that the identification between the gravitational field and the metric-causal [foreground-causal] structure of spacetime holds, and must be taken into account even in the quantum regime. No split of the metric [foreground] is made, and there is no background metric [foreground taken as a background] on spacetime.

One can still describe spacetime as a (differentiable) manifold (a space without metric structure), over which quantum fields live. A classical metric structure will then be defined only by expectation values of the gravitational field operator. Thus, the problem of quantum gravity is the problem of understanding what is a quantum field theory on a manifold, as opposed to quantum field theory on a metric

> space. This is what gives quantum gravity its distinctive flavor, so different from ordinary quantum field theory. In all versions of ordinary quantum field theory, the metric of spacetime plays an essential role in the construction of basic theoretical tools (creation and annihilation operators, canonical commutation relations, Gaussian measures, propagators …); these tools cannot be used in quantum fields over a manifold.[901]

What all of this comes down to is, is there a unity which will find resolution in *phusis*, inclusive of what we now call physics and philosophy? Or is there a discontinuity which cannot find sublation, which must remain as contradictory to logic, to the principle of non-contradiction. Complementarity is not sublation. Complementarity is exteriority which remains as such. It seems to me that infinites in relativity are able to smooth over ruptures in *phusis* mathematically which does introduce a certain amount of symmetry and eloquence. However, when we have non-linearities which cause us to chop up our continuous mathematical functions into regions we tend to brush those aside as not having enough information. Certainly, not having enough information is valid but if we also have the idea that underlying *phusis* is information that we simply do not know yet and will know in the future when our knowledge is more complete, we end up with an ontology and epistemology based on deferment. This is not in agreement with the main tenet of Bell's Theorem which has generally been accepted as discrediting a one day we will find symmetry, cause and effect, the classical history of origin rooted by non-contradiction and rationalism in epistemology and existence as rooted in Being, Concept, the absolute.

But at what human cost does perpetual deferment to the constraints of classical certainty, of logic and binary dualities, in the 'yet to be known of knowledge' validate our history moving us towards ever increasing violent and fictional narratives of origin,

rule and authority? Later, we will see Levinas tells us at the cost of war and its necessity peace, peace as war's detent, war's perpetual pause between apocalyptic murder. But for now, in this context, entanglement is already a rupture which is *the characteristic trait of quantum mechanics*. After entanglement we no longer have the option of reactionary retreat from *phusis*. We have met the enemy, and the enemy is us.

In this section I have shown that in some odd way there is an unresolved complementarity which cannot be sublated, taken up, transformed into a higher order. Complementarity is an interruption of the endless deferments of reality, of Being, of Concept to a recognition which cannot find resolve according to Bell's Theorem and accepted physics. In an analogous way that the speed of light implied that spacetime had to be curved, Complementarity has proven that it's contradiction cannot be resolved in principle and thus in everything we thought was 'reality' and existence. So 'reality' and existence have to override our historic sense of logic, non-contradiction, and resolution. As Levinas will tell us radical alterity as the other, the he or she, cannot be brought into essence, Concept, or resolve but must remain an irrecuperable externality requiring responsibility. Additionally, physics informs us that entanglement will not be explained by locality. Entanglement will not and cannot in principle emerge from spacetime but spacetime emerges from an uncaused, entanglement, which cannot and will never find resolve in spacetime and the history of thought. Origin will never be able to validate itself in itself as rule, authority. Origin can only ever after only defer its resolution, its Concept, because it is rooted in a desire which cannot be bridged which, in what the French call 'bad faith', we call a metaphysic.

In relativity time and space is geometry which relates frames to other frames. Relativity is a step away from absolutes of time and space to the absolutes of light. Relativity mathematics results in infinities as singularities and symmetries. In loop quantum gravity, we saw the abstraction of geometry in terms of an evolving future

coupled with the worldlines of a concrete branching past. The nexus of both future and past, abstract and concrete, is the spooky externality of physics' exformation and *phusis'* stretch of lived time and lived space. The crossing is the living present which branches as informational updates. The nexus and the crossing never meet in *phusis*. They remain on the hither side of the abyss of exformation. They are not related by cause and effect. They are not mediated in Being. They are not resolved by non-contradiction, a higher order which establishes them in contradistinction to each other. So, how can we think about spacetime as emergent, branching from the quantum wave function?

The article cited in the quote below is entitled, "Time might not exist, according to physicists and philosophers, but that's okay." As we saw, the quantum wave function *assumes* a sense of unitarity meaning the wave function can go forward and backward in not just time evolution but also unitary operators which preserve vector spaces, distance, angles, rotations, spin, etc. Unitary operators ensure that physical properties like the ones just mentioned are consistent under transformations. This means through perturbation, perturbed changes, waves can preserve certain aspect of their vector space, their environment, referred to as an identity operator meaning phenomenon does not just go poof but can change wildly, unpredictably. In wave function collapse or measurement decoherence destroys unitarity. In order to make probability predictions the unitary assumption only makes practical sense when experimental situations are tightly controlled, mostly eliminating environmental influences, and going forward in time. However, actually trying to go backwards in time evolution in an experiment would not be a practical reality since, due to the decoherence of measurement, the whole environment, the universe would be implicated. A further assumption which could never be proven is that wave functions no matter how complex they get and even after they disappear into chaos is still bound to unitarity.

So, many quantum physicists have effectively given up on

thinking time has any quantum reality and even that time is emergent from quanta. But, no worries, they still are able to utilize causality in the simpler experiments to predict probabilities upon collapse or branching so that seems to suffice.

> While physics might eliminate time, it seems to leave causation intact: the sense in which one thing can bring about another. Perhaps what physics is telling us, then, is that causation and not time is the basic feature of our universe. If that's right, then agency can still survive. For it is possible to reconstruct a sense of agency entirely in causal terms. At least, that's what Kristie Miller, Jonathan Tallant and I argue in our new book. We suggest the discovery that time does not exist may have no direct impact on our lives, even while it propels physics into a new era. 902

What follows may be too difficult at this point in the discussion, but I will go through it more slowly later. We are not related to or have power over the spooky wave function. Temporality and spatiality are not physical in the wave function. The wave function is a spooky other to time and space, and even my lived time and lived space. We respond to the radical exteriority of the otherness of the other, the he or she we face, which finds no home in history, in Being, absolute space and time. *Phusis* is not the duality of physics and philosophy. *Phusis* is an ethic of responsibility in the face of alterity, a time not my time, a diachrony of time which cannot be bridged or synchronized.

> The structure of the experience of alterity can be expressed in terms of temporality, which is the internal format of subjectivity. The openness by which subjectivity opens to things is itself opened by the internal scission of the instant of its presence, the internal movement of its moment whereby it does not hold itself together in utter identity, but

> splits, gets out of phase with itself, and clings to itself despite this fission. The present is already passing, bypassing itself (*se passe*). This diachrony which is already in the instant itself makes the instant of a subjective stance not a coinciding with itself, but already a gaping open of itself and a clinging on to itself. An internal openness, and a retention and protention of itself even in the instant when it coheres to itself and posits itself as present, the present is the span of time in which the data that affect it are also retained, synchronized, synthesized. (Levinas, Otherwise Than Being or Beyond Essence, 1981, pp. 21-22)[903]

The other as what we will see Levinas calls pre-originary proximity is the calling of responsibility which is already before me always already pre-conditioning idea as language and history into the sameness of time and space thought classically and assumed by common sense. My embodiment in the midst of the panoply of beings which plays out as intentionality is not hermetically sealed in Descartes *cogito*, the thinking thing. It is not prior as an absolute synchronicity in any such notion as a universal temporality. The narrative of temporal synchronicity references the past and the future as my present idea of what was retained and what will be retained called protention. In my lived embodiment present, retention has a meaning bestowing passivity we think as my living past. In my lived embodiment present, protention has a meaning bestowing passivity on the future which awaits me as my future life. It is synchronized to the self-interested me. In transactionalism everyone else's past and future also finds its synchronization in my time. But Levinas, like the quantum wave function, thinks of time as diachronous. Time cannot be synchronized as the universality of my time, my present, from which others exist.

Chronía or khrónos in ancient Greek is time. In Greek mythology Cronus was the son of Uranus (heaven) and Gaea (earth). His mom advised him to castrate his father to become king of the Titans. He

did so which separated heaven and earth and made him king. Diachronic in Greek is *diachronía*. The *dia* in diachronic, meaning through and rooted in *two*, is not synchronous. Synchronous in Greek is *súnkhronos*. The *syn* in 'synchronous' is together. Time and space split off from quantum wave function branching. Branching is not universal as if everyone branched from me. We do not branch in ownership of the universe where everyone else is an illusion of me (unless you are a narcissist). We branch spookily, not reducible to me alone or me with everyone else. Historic narrative informs us not to pay any attention to that spook behind the curtain (Wizard of Oz). We branch into significance from what can only be thought of as the spooky observer effect. Analogously, Levinas is referring to this in his notion of diachrony.

> But Levinas argues that this model of time [as synchronous] and the kind of subject that it supports is not the only significance that time carries for us. If we begin with the lived experience of time, what stands out is its passing and how the self passively undergoes that lapse. Diachronous time resists representation, in a passing that cannot be reduced to insignificance: "the past bypasses the present.… It cannot be recuperated by reminiscence not because of its remoteness, but because of its incommensurability with the present. The present is essence that begins and ends, beginning and end assembled in a thematizable conjunction. … Diachrony is the refusal of conjunction, the non-totalizable" (Levinas, Otherwise than Being or Beyond Essence, 1981, p. 11). This is the movement of time in which the knower or the agent is immersed rather than being able to stand back from it, such that one might find oneself already entangled in a situation or already committed without having made a decision. Robert Gibbs describes this state as the interruption of representation: "My narration is broken into by something that I cannot make part of the

story." Diachrony is thus what unsettles the self in its incessant intentional activity, its comprehension of the world. Formal conceptions of time ignore diachrony in reducing time to what can be synchronized by consciousness. [904]

The diachrony of time is the calling of responsibility.

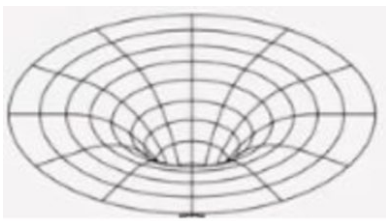
But Levinas takes a more radical approach by arguing that the meaning of time is not the possibility of free will outside of a spatialized, mechanistic world; the intentional integration of past, present, and future; my own being-toward-death; or the disclosure of a spiritual order of creation, revelation, and redemption. Instead, time has an ethical significance that dismantles my ability to comprehend the other. In arising out of an "immemorial past," responsibility cannot be made fully present to consciousness. Its hold on the self therefore emerges unexpectedly, introducing a traumatic demand on the self that challenges the logic of knowing and even deliberating and willing. In this way, time has a destabilizing effect on "the unity of the I think" that characterizes the autonomous subject. [905]

The opposition between synchrony and diachrony thus maps onto the opposition between totality and infinity. The former aspect of time supports the activity of representation that binds events into a unity, whereas the latter opens up the possibility of a relation to that which resists representation or conceptual assimilation. The subject is exposed to the other in such a way that the other exceeds comprehension but is nonetheless in relation to the self. We encounter responsibility too late to be able to refuse it, to negotiate a different obligation, to make or retract a promise, or even to put limits on the scope of that responsibility: "Responsibility is anterior to all the logical deliberation

summoned by reasoned decision.… In the ethical anteriority of responsibility, for-the-other, in its priority over deliberation, there is a past irreducible to a presence that it must have been" (Levinas, Entre Nous: On Thinking-of-the-Other, 2000) ("Diachrony and Representation." In Entre Nous: Thinking-of-the-Other, 1998, p. 111). It is in this sense that the other addresses the self in the accusative—and Levinas exploits the ambiguity of this term to refer both to the grammatical case (of being neutrally addressed) and to the more specific moral connotation of culpability. But diachrony is fundamentally an experience of a commitment that does not arise out of the subject's choices: "The responsibility for the other can not have begun in my commitment, in my decision. The unlimited responsibility in which I find myself comes from the hither side of my freedom, from a 'prior to every memory,' an 'ulterior to every accomplishment,' from the non-present par excellence, the non-original, the an-archical" (Levinas, Otherwise than Being or Beyond Essence, 1981, p. 10). For Levinas, the movement of time demonstrates the limits of our self-possession. The unlimited quality of responsibility lies in its an-archy, its lack of a determinate origin and governing structure. On Levinas's reading, responsibility thus cannot be defined by a series of obligations that can be ascertained by cataloging one's own actions, intentions, or particular relationship with the other. It precedes such questions, which Levinas consigns to the realm of justice—the domain in which we must treat the other as one person among others, whose interests must be weighed against other obligations. But the ethical itself does not allow this kind of calculation and limitation on my responsibility. Paradoxically, diachrony carries meaning precisely because its meaning cannot be thematized or made intelligible. Its significance burdens or imposes itself on the subject insofar as it escapes

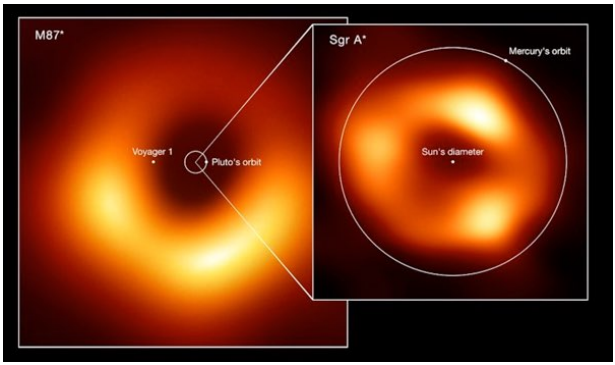
representation. The deformalization of time leaves us with a signification that cannot be assimilated as just another intentional object, a neutral sensation, or experiential content that can be comprehended and integrated into an ongoing narrative of the knowing subject. In this way, diachronous time undermines the primary activity of intentionality, which Levinas associates with the autonomy of consciousness. 906.

BLACKHOLES



The End of Spacetime 907

Size comparison of the two black holes imaged by the Event Horizon Telescope (EHT) Collaboration: M87*, at the heart of the galaxy Messier 87, and Sagittarius A* (Sgr A*), at the centre of the Milky Way. The image shows the scale of Sgr A* in comparison with both M87* and other elements of the Solar System such as the orbits of Pluto and Mercury. Also displayed is the Sun's diameter and the current location of the Voyager 1 space probe, the furthest spacecraft from Earth. M87*, which lies 55 million light-years away, is one of the largest black holes known. While Sgr A*, 27 000 light-years away, has a mass roughly four million times the Sun's mass, M87* is more than 1000 times more massive. Because of their relative distances from Earth, both black holes appear the same size in the sky.



908

Credit: EHT collaboration (Acknowledgment: Lia Medeiros, xkcd)
xkcd - A Webcomic - License

Now, I want to turn blackholes. Blackholes are no longer fiction. They are at the core of galaxies including our own Milky Way galaxy. On August 14, 2017, at 10:30:43 UTC the Laser Interferometer Gravitational-Wave Observatory (LIGO) detected gravitational waves which ripple in the very fabric of spacetime. These gravitational waves were produced by the merger of two stellar mass blackholes. Blackholes are normally made by the collapse of a large star. The star's collapse also produces a large gamma ray burst.

> The detected gravitational waves—ripples in space and time—were emitted during the final moments of the merger of two black holes with masses about 31 and 25 times the mass of the sun and located about 1.8 billion light-years away. The newly produced spinning black hole has about 53 times the mass of our sun, which means that about 3 solar masses were converted into gravitational-wave energy during the coalescence.909

There are four types of blackholes: 910

Black hole type	Description	Constraints
Schwarzschild	has no angular momentum and no electric charge	$J = 0$ $Q = 0$
Kerr	does have angular momentum but no electric charge	$Q = 0$
Reissner–Nordström	has no angular momentum but does have an electric charge	$J = 0$
Kerr–Newman	has both angular momentum and an electric charge	

911

There are four types of blackholes which rotate, do not rotate, are charged, and not charged.

	Non-rotating ($J = 0$)	Rotating ($J > 0$)
Uncharged ($Q = 0$)	Schwarzschild	Kerr
Charged ($Q \neq 0$)	Reissner–Nordström	Kerr–Newman

912

All four of these blackholes are supported by Einstein's field theories of relativity. There are blackholes which rotate and blackholes which do not rotate. According to the current understanding of black holes, it is unlikely that a non-rotating black hole exists in nature. All known stars rotate, and when a star collapses to form a black hole, the conservation of angular momentum means that the black hole is likely to have some angular momentum as well. Even if a star with a non-rotating core were to collapse, the subsequent accretion of material with angular momentum would give the black hole that angular momentum. In theory, a non-rotating black hole could be formed by the collapse of a non-rotating star, but there is no proof that such a star exists. It is also theoretically possible to extract angular momentum from a rotating black hole via the Penrose process to create a non-rotating black hole. However, non-spinning black holes are a theoretical ideal that is unlikely to be found in nature. 913 Additionally,

charged blackholes are also not expected to exist in nature. [914] This one leaves the rotating, non-charged blackhole, the Kerr blackhole as the only known blackholes in the universe. Here are more detailed explanations of each type of blackhole,

Schwarzschild Non-rotating, Uncharged Blackhole

In Einstein's theory of general relativity, the Schwarzschild metric (also known as the Schwarzschild solution) is an exact solution to the Einstein field equations that describes the gravitational field outside a spherical mass, on the assumption that the electric charge of the mass, angular momentum of the mass, and universal cosmological constant are all zero. The solution is a useful approximation for describing slowly rotating astronomical objects such as many stars and planets, including Earth and the Sun. It was found by Karl Schwarzschild in 1916. [915]

Reissner–Nordström Non-rotating, Charged Blackhole

In physics and astronomy, the Reissner–Nordström metric is a static solution to the Einstein–Maxwell field equations, which corresponds to the gravitational field of a charged, non-rotating, spherically symmetric body of mass M. The analogous solution for a charged, rotating body is given by the Kerr–Newman metric. [916]

Kerr metric Rotating, Uncharged Blackhole

The Kerr metric or Kerr geometry describes the geometry of empty spacetime around a rotating uncharged axially symmetric black hole with a quasispherical event horizon. The Kerr metric is an exact solution of the Einstein field equations of general relativity; these equations are highly non-linear, which makes exact solutions very difficult to find. [917]

Kerr–Newman metric Rotating, Charged Blackhole

The Kerr–Newman metric is the most general asymptotically flat, stationary solution of the Einstein–

> Maxwell equations in general relativity that describes the spacetime geometry in the region surrounding an electrically charged, rotating mass. It generalizes the Kerr metric by taking into account the field energy of an electromagnetic field, in addition to describing rotation. It is one of a large number of various different electrovacuum solutions, that is, of solutions to the Einstein–Maxwell equations which account for the field energy of an electromagnetic field. Such solutions do not include any electric charges other than that associated with the gravitational field, and are thus termed vacuum solutions. 918

The Kerr-Newman blackhole is the only blackhole which takes a non-zero cosmological constant into account. 919 In addition, blackholes are categorized by their size. One solar mass is approximately equal to the mass of our sun.

Black holes are completely characterized by three parameters: mass, rotation (spin) and charge. There are now thought to be 4 main types of black holes if classified by mass:

1. **Primordial Black Holes** have masses comparable to or less than that of the Earth. These purely hypothetical objects could have been formed through the gravitational collapse of regions of high density at the time of the Big Bang.
2. **Stellar Mass Black Holes** have masses between about 4 and 100 solar masses and result from the core-collapse of a massive star at the end of its life.
3. **Intermediate Mass Black Holes** of 102 and 105 solar masses may also exist. The first good IMBH is the X-ray source HLX-1, seen in projection near the centre of the S0 galaxy ESO 243-49. 920
4. **Supermassive Black Holes** weigh between 105 and 1010 solar masses and are found at the centres of most large

galaxies. 921

Blackholes are classified based on their mass. The ranges of masses for blackholes are always being reassessed so I will include minimum and maximum sizes in what follows. The most common types of blackholes are stellar-mass, supermassive, and intermediate-mass blackholes. Stellar-mass black holes are formed when a star with more than several times the Sun's mass runs out of fuel, its core collapses, rebounds, and explodes as a result of a supernova. The mass of a stellar blackhole can be from tens to hundreds of solar masses and can fit inside a ball with a diameter of about ten miles. Supermassive blackholes are found at the center of almost every large galaxy, including our Milky Way. Supermassive blackholes can be hundreds of thousands to billions of solar masses. Intermediate-mass blackholes are hypothesized to exist, but their existence has not been confirmed yet. Intermediate-mass blackholes can be from hundreds to thousands of solar masses. 922

A charged black hole is a black hole that possesses electric charge. However, it is not expected that black holes with a significant electric charge will be formed in nature because the electromagnetic repulsion in compressing an electrically charged mass is dramatically greater than the gravitational attraction (by about 40 orders of magnitude). A black hole can be completely characterized by three (and only three) quantities: M – mass, J – angular momentum, Q – electric charge.

What Is a Black Hole? (Grades 5-8) - NASA
Charged black hole - Wikipedia
Black Hole Paradoxes Reveal a Fundamental Link Between Energy and Order | Quanta Magazine
electromagnetism - Do black holes have charges? - Physics Stack Exchange

Blackholes with angular momentum spin. When stars collapse,

they are spinning. This spinning motion is translated to the blackhole. Spinning blackholes can generate heat or lose heat. Generally, it is believed that blackholes do not have any appreciable electric charge because charge in either direction, positive or negative, gets neutralized quickly by the blackhole. Therefore, the most common type of blackhole is a Kerr blackhole, spinning without charge. One blackhole in our galaxy (GRS 1915+ 105) may rotate 1,150 times per second.[923]

Primordial blackholes are hypothetical blackholes that formed soon after the Big Bang. In the inflationary era and early radiation-dominated universe, extremely dense pockets of subatomic matter may have been tightly packed to the point of gravitational collapse, creating primordial blackholes without the supernova compression needed to make blackholes today. Because the creation of primordial blackholes would pre-date the first stars, they are not limited to the narrow mass range of stellar blackholes. Primordial blackholes are non-baryonic, and as such are plausible dark matter candidates. They are also good candidates for being the seeds of the supermassive blackholes at the center of massive galaxies, as well as of intermediate-mass blackholes. However, their existence has not been proven and remains hypothetical. In September 2022, primordial blackholes were proposed by some researchers to explain the unexpected very large early galaxies discovered by the James Webb Space Telescope (JWST). [924]

There has been speculation by cosmologists that a primordial blackhole might have been magnetically charged by the existence of quantized particles called monopoles. These monopoles which charged blackholes are thought to have existed shortly after the Big Bang and perhaps even today although none have ever been found. Cosmologists believe that monopole charged blackholes could have been created during the inflationary period. There are also types of monopole particles that fall out extensively from solving Einstein's field equations in general relativity. Monopoles have been and continue to be intensely sought after, but none have been found

yet.[925] Monopoles would be magnetic particles which only have one pole. A monopole is like a magnet except without opposite magnetic poles, positive and negative or north and south poles as they are normally called. Even if you cut a magnet in two each part will have a positive and negative pole. The magnetism we are all familiar with is due to particle property of spin of electrons, protons, and neutrons.[926] This type of magnetism creates dipoles, having two poles – positive and negative poles.

If magnetic monopoles were ever found it would mean that magnetism arises from quanta not from an electric field. Electric fields arise in electrons and protons as quantum mechanical spin in opposite directions.[927] Common magnetic fields are emergent from an electric field. If a monopole existed in nature, it would arise from a quantum particle that is referred to as magnetic charge. In 1931 Paul Dirac proposed that monopoles may exist. Monopoles have been created in the laboratory by placing matter in a state called a Bose condensate. At temperatures very close to absolute zero kelvin a high density, condensed matter superconductor called a Bose condensate can create artificial monopoles. Whenever an electric current runs through a wire there is resistance to its flow which means power is lost in the transmission of electricity. Superconductors have zero resistance to electric current flow. The reason for this is due to a super insulator which isolates the current flow from the rest of the universe. There has been much speculation over the years that dark matter may be related to monopole quanta.[928]

It turns out that black holes have a lot to tell us which goes way beyond black holes themselves. When a large star collapses the density of matter becomes so large that spacetime itself collapses in on itself. Solving the blackhole mystery will solve the biggest problem in physics, how to resolve the very small of quantum mechanics to the very large of spacetime. Blackholes perform both of these functions. They work in the quantum world as a singularity. They also work in spacetime with the most extreme

distortions of spacetime resulting in huge amounts of gravity due to that extreme spacetime curvature. Anything which enters the event horizon of a blackhole disappears from our universe, our time and space. Some have said that this means material entering the blackhole goes faster than the speed of light. This is incorrect. What actually happens is that spacetime itself falls into the blackhole. This is called infalling or more properly frame dragging where literally space itself is falling into the blackhole. Since spacetime itself is infalling, there is no speed limit of light. *Although nothing can travel through space faster than light, space itself can infall at any speed.*[929] First, I want to look at the notion of a blackhole singularity.

Blackhole Singularity

The first thing to know about blackhole singularities is that they do not exist. According to the laws of physics, singularities are points where mathematics "misbehave," typically by generating infinitely large values. Singularities can happen anywhere, and they are surprisingly common in mathematics that physicists use to understand the universe. However, singularities are not considered real by scientists. Singularities are the non-physical mathematical result of a flawed physical theory. Though they sound exotic, mathematical singularities are actually common in solutions to all but the simplest equations in physics. The fact that General Relativity predicts that singularities are inevitable under certain conditions is proof that general relativity is wrong. [930] While we may not know what happens inside a blackhole we do know that as we look back in spacetime the universe gets smaller and smaller. We know that supermassive blackholes are at the heart of large galaxies. We know that smaller blackholes exist in the universe. We know that some blackholes are created when a massive sun collapses in on itself. We know that gravity around a blackhole is so enormous that at some point even photons hit a point of no return.

So, what exactly do we mean by the idea of a singularity?

As we have seen with the quantum wave function, existence is not necessarily all it is cracked up to be (or the 'not' of to be). The quantum wave function is mathematical but also something else which has multiple interpretations. However, what all these interpretations really tell us is that we cannot find easy classical categories to fit the quantum wave function into our narrative pegboard of easy answers. If existence were the only category available to us there would absolutely be no place for the idea of the quantum wave function which has nothing to do with state reduction, the observer effect, and spooky entanglement. The wave function is mathematical but cannot simply be thought of as purely abstract mathematics. The way in which the oddities of the wave function hover hazily over classical ontology and epistemology should tell us something about *us*. To stubbornly hold on to some positivistic faith that one day the history of empiricism which historically arrives to us fundamentally as a misguided notion of modernist metaphysics where 'reality' is 'inert matter' (thingness, objects, substance, etc.) will finally be vindicated in a deterministic universe of absolutes and universal truths, the sum of all knowledge. The cardinal sin of modernist history is to question its universality. But this is exactly what quantum physics does in no uncertain terms (or should I say an excess to the certainties of all our terms).

On the other hand, we cannot think of the quantum wave function as purely theoretical physics. The wave function has real probabilities which give us real, predictable results. Singularities are purely theoretical. And as we will see there are different ideas about what a 'singularity' might mean or even other ways which do not even employ the term singularity as a catch all. The wave function has 'real' observer effects falling into classicism. It has analogies or metaphors in superposition which result in a certain amount of predictability in the 'real' world. We call this semiclassical. Yet, the wave function hovers in between many

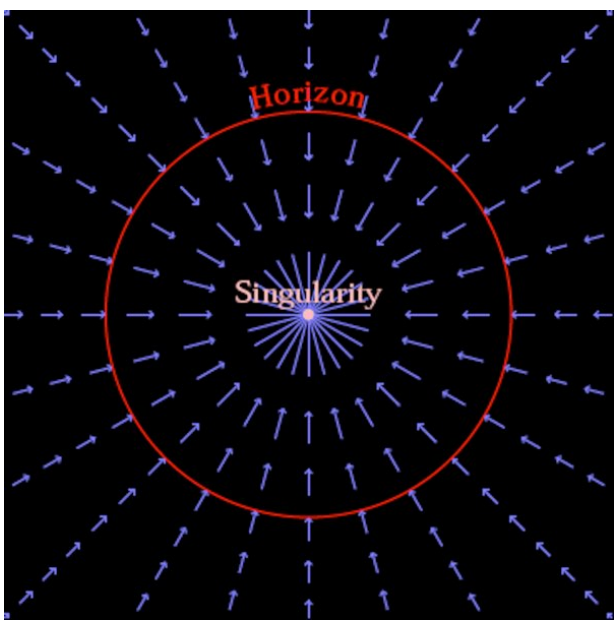
interpretations which cannot exclude philosophy. The wave function is endemic to philosophy. With the advent of quantum mechanics, philosophy is no longer optional. While the question of our conceptions of a singularity is open, there are multiple ideas about the wave function's fall (state reduction, collapse, branching, etc.?) into spacetime in the form of gravitational extremities in the universe, cosmology, and even in the tiniest of quanta. I will use the term singularity for brevity knowing the term has inherent difficulties. In this section I want to explore how physicists have thought the breakdown of spacetime by massive distortions of its geometry function as holes are tears in the very fabric of spacetime. The event horizon of a blackhole is all we can observe. It is a circular surface where our universe ends and something else begins. I want to look at a few ideas about what else might begin below the event horizon of a blackhole.

A singularity is a point in the universe where our laws of physics break down. It is a place where the mathematics of physics break down, such as the center of a black hole or the beginning of the Big Bang. Singularities can happen anywhere, and they are surprisingly common in the particular mathematics that physicists use to understand the universe. Put simply, singularities are places where mathematics "misbehave," typically by generating infinitely large values. Singularities don't represent something physical. Rather, when they appear in mathematics, they are telling us that our theories of physics are breaking down, and we need to replace them with a better understanding. For example, the center of a black hole is commonly thought of as an example of a singularity. The force of gravity compresses matter down into an infinitely tiny point, so that it occupies literally no volume. This sounds impossible, and it is. The singularity at the center of a black hole is an example of a place where our theories of physics, the 'laws of physics', break down. 931

A Gravitational Singularity

The diagram below is called a Schwarzschild blackhole. Outside the horizon, the infall velocity is less than the speed of light. On the horizon, the velocity equals the speed of light. And inside the horizon, the velocity exceeds the speed of light. This hypothetical blackhole has no angular momentum (does not rotate) and has no charge.

> The picture of space falling into a black hole has a sound mathematical basis, first discovered in 1921 by the Nobel prize-winner Alvar Gullstrand2, and independently by the French mathematician and politician Paul Painlevé, who was Prime Minister of France in 1917 and then again in 1925.
>
> It is not necessary to understand the mathematics, but I do want to emphasize that, because the concept of space falling into a black hole is mathematically correct, inferences drawn from that concept are correct. 932

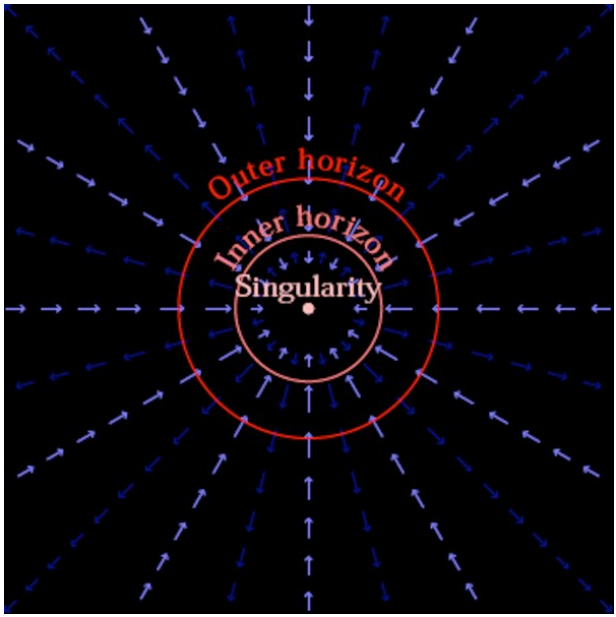


Note: If the animation does not work click on the link in the footnote.

The diagram below is called a Reissner-Nordström blackhole. This hypothetical blackhole has no angular momentum (does not rotate) but it has charge.

> The waterfall model works equally well for a charged black hole, the Reissner-Nordström geometry. However, whereas in the Schwarzschild geometry the waterfall falls at ever increasing velocity all the way to a central singularity, in the Reissner-Nordström geometry the waterfall slows down, thanks to the gravitational repulsion produced by the tension, or negative pressure, of the electric field…
>
> The infall velocity of space passes the speed of light at the outer horizon, but slows back down to less than the speed of light at the inner horizon. The velocity slows all the way to zero at the turnaround point inside the inner horizon. At this point space turns around and accelerates back out, hitting the speed of light once more at the inner horizon. Space now enters a white hole, where space is moving outward faster than light. The diagram at left seems to show the white hole in the same place as the black hole, but actually, as is apparent in the Penrose diagram, the white hole and black hole are distinct regions of spacetime. As space falls outward in the white hole, the gravitational repulsion produced by the negative pressure of the electric field weakens relative to the gravitational attraction produced by the mass. The outfalling space slows back down to the speed of light at the outer horizon of the white hole. Space then emerges into a new region of spacetime, a new universe perhaps.
>
> Does all this sound bizarre? Yes it is. Sadly, the whole picture of space turning around and shooting back out through a white hole into another spacetime does not happen

in reality. Although the Reissner-Nordström geometry is an exact mathematical solution of Einstein's equations, in reality the geometry is subject to a violent instability at the inner horizon. [934]



[935]

Note: If the animation does not work click on the link in the footnote.

And here is your typical wormhole.

When did you last see a waterfall that cascaded down one side of a ravine and leapt up the other?

Well, that doesn't happen in reality, and it doesn't happen in black holes either.

In a waterfall, water bouncing off the bottom of the ravine collides with water streaming down the falls, producing a turbulent chaos of water at the bottom of the

waterfall.

Something not greatly different happens inside a charged or rotating black hole. Since space has no substance (according to relativity), as long as the black hole is empty, then there is no problem with space going in two different directions at once. But the moment any actual stuff falls into the black hole, as it surely does in reality, then stuff trying to fly back out collides with stuff still falling in. As at the bottom of a waterfall, the result is energetic chaos deep inside the black hole.

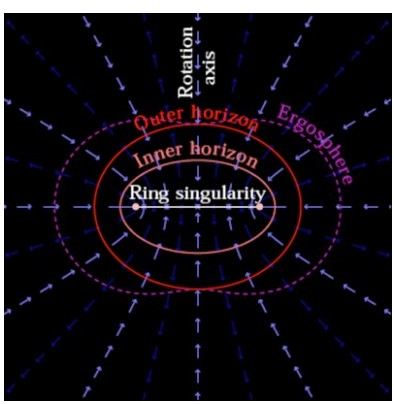
A mathematician might construct a solution in which a waterfall fell down one side of a ravine, turned smoothly around, and fell up the other side, conserving energy and momentum, and generating no entropy. The mathematician might argue that indeed that is the simplest mathematical solution for a waterfall. But in reality such a waterfall never happens. [936]

[937]

Note: If the animation does not work click on the link in the footnote.

The diagram below is called a Kerr blackhole. This hypothetical blackhole has angular momentum (it rotates) and has no charge.

> The geometry of a rotating black hole is described by the Kerr metric, discovered by the New Zealander Roy Kerr in 1963. The Kerr geometry shares with the Reissner-Nordström geometry the property of having an inner horizon, which connects to a white hole, which connects to a new universe.
>
> The centrifugal force causes the horizon of the black hole to bulge out into an ellipse. The same centrifugal force opens the singularity into a ring. The outer horizon and inner horizon form confocal ellipsoids, with the ring singularity at the focus of the ellipsoid.
>
> The rotating black hole drags space around with it. Outside the horizon of the black hole is a region called the ergosphere, where space is dragged around so fast that nothing can remain at rest there. A former student once called the ergosphere the place where little children come from, because nothing can remain at rest there. 938

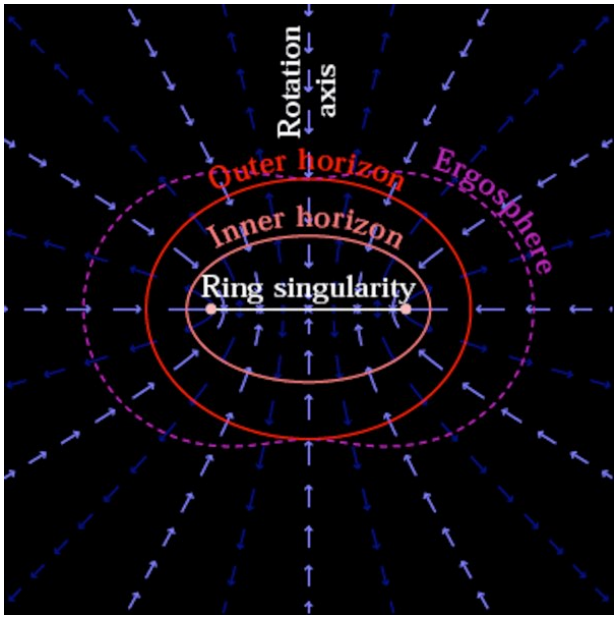


939

Note: If the animation does not work click on the link in the footnote.

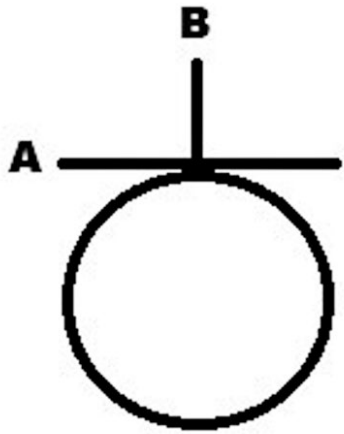
The white hole ‘inside’ the blackhole is like an island which is ‘outside’ the blackhole. This is confusing and will be discussed later. Oh, here is the universe or better anti-verse which comes with it.

> If you pass through the disk bounded by the ring singularity of the Kerr black hole, then you enter a different region of space, the antiverse. The antiverse continues the Kerr geometry to negative radius (in ellipsoidal coordinates). An observer in the antiverse perceives the Kerr geometry to be a rotating black hole of negative mass.
>
> Winding around the ring singularity is a toroidal region, which I call the Sisy-tube, containing closed time-like curves (CTCs). An observer who circulates retrograde around the torus can find themself joining to their own past. Like Sisyphus, they are doomed to repeat the same loop of time for ever.
>
> Sadly, from its inner horizon inward, the Kerr geometry is not a realistic model of an astronomical black hole, because the Kerr geometry is subject to the inflationary instability at its inner horizon. 940



Note that the Schwarzschild blackhole and the Reissner-Nordström blackhole both have point singularities. The Kerr blackhole and the Kerr–Newman blackhole both have ring singularities. The reason for this is that both the Kerr and Kerr–Newman blackholes rotate. The Schwarzschild and Reissner-Nordström blackholes do not rotate.

In geometry if we think about one point on a curved surface at the intersection of line A and B below, the surface at A will have a tangent of 90 degrees shown as B. As we go around the circle, we expect that we will always have the same line and its tangent albeit at different angles as we move around the circle. Intuitively we think that this always happens.

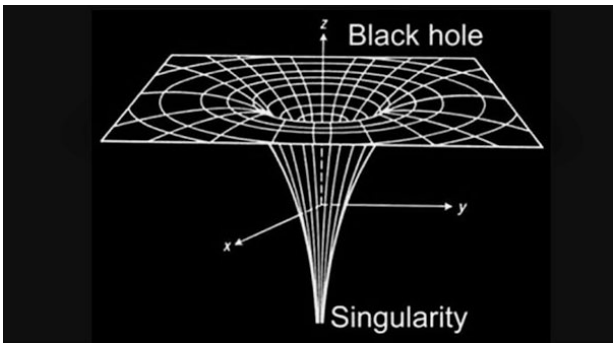


942

But in the geometry of spacetime there will be a point at the intersection of A and B where line A will exist, it will be finite, but line B tangent to the surface of spacetime at that point (A and B) will not exist. Why? Because it is a singularity. Point B will be infinite. Another way of thinking this is that point B will disappear. Lines A and B could also be two dimensional planes. Whether it is a line, or a plane B is called an affine line or plane. It is also called an 'inextensible geodesic'. So, the affine line or plane simply goes poof at a singularity. In a nutshell this is what happens in the geometry of general relativity when a singularity occurs. The bottom line is that we are cruising along in spacetime where everything is groovy and all of a sudden there is no spacetime. Ok, sounds like a bad acid trip but it is 'reality'. There are two components to this which are contradictory or shall I say bipolar dualities. The 'is' of 'there' is definitely finite. All around the singularity everything is cool. And at the same time, there is an infinity, no time, no space, and both are 'there'. But now the notion of 'there' has changed significantly.

There are different types of singularities such as the different shapes. A singularity might be conical or curved. A conical singularity is like an ice cream cone where the singularity becomes

an infinitesimally small point. Spacetime curves inward into an infinitesimal point like the diagram below.



943

In mathematics a conical singularity is a ‘limit of a diffeomorphism invariant quantity’. Let’s dissect what the heck a ‘limit of a diffeomorphism invariant quantity’ is. A diffeomorphism invariant quantity is the idea that coordinates do not exist *a priori* in nature, but are only artifices used in describing nature, and hence should play no role in the formulation of fundamental physical laws. No matter what coordinates are used a diffeomorphism invariant quantity will always be infinite. A scalar is a number which has no direction like a constant. It can be like a magnitude of force, the strength of a force. But a force can also have a direction, which direction the force is applied to, that is mathematically described by a vector. A ‘diffeomorphism invariant quantity’ can be a simple scalar. In the case of a scalar as a ‘diffeomorphism invariant quantity’ means the scalar, the magnitude, becomes infinite. A conical singularity is when a single point just suddenly becomes nonexistent. We may be going along in a coordinate system and hit an infinity at a certain point with no rhyme or reason. Generally, as mentioned before, singularities are taken by physicists as an inadequate understanding due to a lack of information.

When physical infinities show up at a scalar point, general relativity physicists are skeptical about them. On the other hand, there are some universal constants which are kind of like simple scalars like the Planck constant which show up in physics and are not generally contested. Some of these physical constants are even dimensionless, constants which are simple real values. You can see a table of some of these constants here,

List of physical constants - Wikipedia

In a way many of these constants show up no matter what coordinates or geodesics are used. Let's remember that geodesics in physics are like topological contour maps. But they can be any number of dimensions. They simply 'are'. There is much mystery around some of these constants, but their acceptance has become conventional in physics. Because there is a history of infinities in mathematical physics which later turned up to be due to a lack of understanding, infinities do not rest so easy with contemporary physicists.

At the center of a general relativity's singularity the gravitational density is infinite with zero volume. At the event horizon, spacetime itself is dragged down to a singularity which is infinitely small.

> A gravitational singularity, spacetime singularity or simply singularity is a condition in which gravity is predicted to be so intense that spacetime itself would break down catastrophically. As such, a singularity is by definition no longer part of the regular spacetime and cannot be determined by "where" or "when". Gravitational singularities exist at a junction between general relativity and quantum mechanics; therefore, the properties of the singularity cannot be described without an established theory of quantum gravity. Trying to find a complete and precise definition of

> singularities in the theory of general relativity, the current best theory of gravity, remains a difficult problem. A singularity in general relativity can be defined by the scalar invariant curvature becoming infinite or, better, by a geodesic being incomplete. [944]

The quote above ends with the words "*a geodesic being incomplete*". A geodesic can be thought of as a kind of contour line on a topographic map. However, in this case instead of densities of elevation gain a geodesic shows various densities of spacetime curvature or gravity. In the case of a gravitational singularity the curvature becomes infinite at a single point. [945] But geodesics can also describe different kinds of properties for sparticles like spin, angular momentum, charge, etc. Think of these as different maps which tell us what these properties do in certain regions of space.

There are two types of rotating curvature singularities, a Ricci and a Weyl singularity. A Ricci singularity is when the scalar curvature, the magnitude of the curvature at a point (like the intersection of lines A and B above) goes to infinity. This is like the Big Bang singularity. It fails in every kind of geodesic map. A Weyl singularity is when the Weyl tensor becomes in!nite. Without getting too detailed a tensor can be thought of as collections of vectors (directions) which in an oversimple way could be thought of as finely tuned initial conditions at some point in spacetime.

There is also something called a naked singularity. [946] It used to be believed that these were impossible but there is dispute about that now in physics. [947] The easy way to think about a naked singularity is to think of a blackhole without an event horizon. An event horizon obscures the singularity itself. The singularity is fully exposed, not clothed with the event horizon, is called a naked singularity. Realistic simulations have shown that it may be possible for a star which has a very high density at its center and slowly decreasing uniformly towards its surface, to collapse in such a way that there would be no event horizon, only a single naked point

which goes to infinity. [948] So, if you passed over it in a rocket ship it might slice you cleanly in two. Ok, these denuded mixed metaphors bring up some immodest, bizarre images so let's try the more technical avenue. Bear with me on this as it is a little technical.

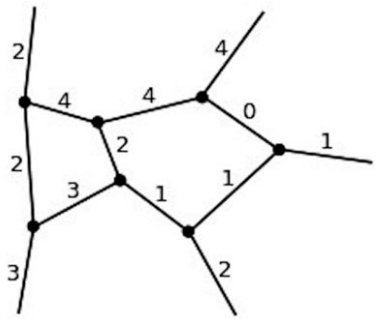
> When there exists at least one causal geodesic that, in the future, extends to an observer either at infinity or to an observer comoving with the collapsing cloud, and in the past terminates at the gravitational singularity, then that singularity is referred to as a naked singularity. [949]

Geodesic Maps and Naked Singularities

I want to try to give a visual analogy of what happens around a naked singularity. Let's remember that a geodesic map is like a contour map which shows us the shortest lines between two points in curved space. It functions like an elevation topology map which shows elevations as lines closer together. While space looks flat it is contoured by mass much like elevations in a mountain range. Even more so space also has 'oceanic wave-like' characteristics due to 'geological-type' transformations from mass which can change temporalities as well as spatialities since spacetime functions according to the general theory of relativity. Large masses result in large spacetime curvatures. With this in mind let's return to loop quantum gravity which provides us with a better approximation of the spin-foam 'oceanic wave-like' idea of spacetime.

Remember that geodesics in physics can be any number of dimensions. They can map out spacetime curvature, particle events, and in loop quantum gravity they can map out temporal changes from changes in spin foam. I want to repeat some of the information previously given about spin foam in loop quantum gravity. Loop quantum gravity tells us that space is composed of chunks of highly entangled quanta which are Planck-scale volumes 10^{99} cm^3 called

nodes or vertices where three-dimensional space exists. The nodes are connected at their boundaries with three lines called worldlines. Let's recall this:



Two-dimensional spin network diagram, after Penrose[950]

The worldlines are made up of a single elementary particle or a compound of elementary particles which have angular momentum.[951] Each worldline has a discrete spin value. A network with a spin number of zero has zero probability of occurring. There are rules for calculating spin value and probabilities of occurring. It is interesting to note that quantum spin, angular momentum, is quantized as h/2 where 'h' is the Planck constant. For fermions such as electrons and quarks, the spin number must always be odd. For bosons such as photons and gluons, the spin number will always be even. The spin number times h/2 is the angular momentum.[952] Three worldlines join at each node.[953] The nodes and links form networks like Tinker toys. These networks are called spin networks.

Roger Penrose is credited with the discovery of spin networks in 1971. The nodes themselves have no direction of time. Spin networks of spin nodes define a three-dimensional hypersurface or curved surface of space. Nodes and links can be added and subtracted like soap bubbles. The network dynamism is called spin foam. The evolution of spin networks comprised of spin foam, has a scale above the order of a Planck length, approximately 10^{-35}

meters, and smaller scales are meaningless. Consequently, not just matter, but space itself emerges from elementary wavicles. The change of spin foam is the emergence of one-dimensional time. Together, the three-dimensional hypersurfaces of spin networks and one-dimensional spin foam changes make up four-dimensional spacetime. This makes loop quantum gravity compatible with Einstein's general relativity. However, instead of Einstein's smooth, continuous transitions of spacetime, loop quantum gravity is composed of chunky, discrete particles. Yet again, we see complementarity of wave and particle.

In this theory, time phenomenologically emerges from the changes in spin foam. In the two-dimensional diagram of the spin network above time flows in one direction - up. For instance, from bottom to top of the diagram[954] causality is conserved in loop quantum gravity. Effectively, gravity, the curvature of spacetime in spin foam, makes up the evolving block universe (general relativity) of worldlines. As I will discuss later, the glue that holds spacetime together is composed of spin foam which is highly entangled particles that gurgle up from zero-point energy or vacuum energy. Like foam from a bubble bath rising upward.

Since time emerges from changes in spin foam, we could make a geodesic map of these space-time like quantum foam events. This might have lines like on a topology contour map. Let's suppose we looked at one worldline and saw that it was going along, had a past, but somewhere in the future it hit a point where it went to infinity and the line disappeared thereafter. That would be an example of a naked singularity, time and space would simply cease somewhere in the future relative to my perspective approaching the naked singularity or the geodesic line.

The Kerr-Newman blackhole can have a naked ring singularity (no event horizon). Let's say we have a naked singularity meaning no event horizon at all at a point on a geodesic map of spacetime according to loop quantum gravity. So, we are bobbing along in our spaceship starting from some geodesic point in the past unaware of

the naked singularity we are approaching. We are happily going along on the geodesic and suddenly the future geodesic simply vanishes. On the other side of the vanishing point the geodesic may simply pick up again as if nothing had ever happened. But what happens to us? Here is a conjecture:

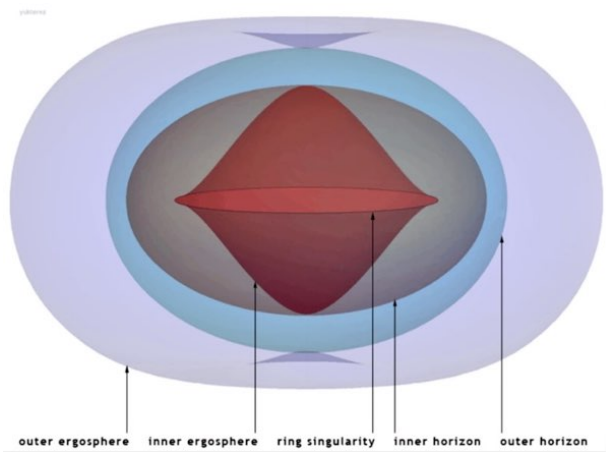
Assuming we were not simply sliced in two on the singular edge of naked singularity😉, our future would simply be no more. Remind you of death? Levinas refers to death as the impossibility of all our possibility meaning death is not experienced. Rather it is a limit where 'me' can never experience it. It is non-relational not to be outstripped. In the current discussion this would be the impossibility of 'experiencing' a naked singularity.

Therefore, spacetime, future and past would cease to exist. But for the quantum wave function there would be no change imposed by the naked singularity since spacetime is simply our relative observer perspective branching as classicism - our world. Our participation in the wave function would not be changed at all by the naked singularity from what we already experience every day. It would be as if our worldline had encountered no pause at all with absolutely no way of ever becoming cognizant of the changes in spin foam. There might be no memory or even possibility of a memory of passing over the vanishing point. Just as 'me here now' in the simultaneity of the wave function has a spooky relationship with the existential of me as existing here now from a personal and classical past embodied in language and commonsense practicality. It seems likely that any such thing as an observer effect has something to do with me here now. The implications of the observer effect in this sense will be explored more later but for now the interruption of the naked singularity may be thought of as radical externality which can never come to sense, to recognition, as classicism's narrative which situates me here now.

But maybe there are no singularities at all. Here is a recipe for making a blackhole,

> If you want to make a black hole, in Einstein's general relativity, all you have to do is take any distribution of pressureless mass — what relativists call "dust" — that starts in the same vicinity and is initially at rest, and let it gravitate. Over time, it will contract down and down and down to smaller volumes, until an event horizon forms at a specific distance from the center: dependent solely on the total amount of mass that you began with. This produces the simplest type of black hole known: a Schwarzschild black hole, which has mass, but no electric charge or angular momentum. 955

Einstein's blackhole which most folks normally think of is the Schwarzschild black hole. But this theoretical blackhole has never been found in the universe. The author of the quote above suggests that if the universe were only made of dust the above statement would be true. Unfortunately, there are these nasty little quantum particles which mess up our perfect dust funnel, general relativity blackholes. The only known blackholes to exist in the universe are Kerr blackholes. They do not have a point singularity. They have a ring singularity. Quantum physics messes up the perfectly symmetrical universe. Fundamentally, symmetry is a classical allusion. Quanta is discrete, noncontinuous, lumpy with no 'stuff' in between. If quanta mess up the beautiful symmetry of the universe, we do not get a nonrotating blackhole. We get angular momentum which means we get blackhole rotation. And charge gets neutralized. We end up with a noncharged, rotating blackhole – the Kerr blackhole. The Kerr blackhole has a 'ring singularity'. Therefore, I will try my best to illustrate how this works.



The Kerr black hole is a rotating black hole that is described by the Kerr metric in general relativity. It has two horizons: the event horizon and the inner horizon. The ergosphere is the region between the two horizons where the spacetime is dragged around by the black hole's rotation. The ergosphere is divided into two regions: the inner ergosphere and the outer ergosphere. The inner ergosphere is located inside the event horizon and the outer ergosphere is located outside the event horizon but inside the static limit. Crossing the inner ergosphere is possible, but it requires moving faster than the speed of light, which is impossible according to the laws of physics. The shape of the inner ergosphere is not well-defined, but it is generally considered to be ellipsoidal. The outer ergosphere is the region where the frame-dragging effect is strong enough to make it impossible for any object to remain stationary.

> When a spherical non-rotating body of a critical radius collapses under its own gravitation under general relativity, theory suggests it will collapse to a 0-dimensional single point. This is not the case with a rotating black hole (a Kerr

> black hole). With a fluid rotating body, its distribution of mass is not spherical (it shows an equatorial bulge), and it has angular momentum. Since a point cannot support rotation or angular momentum in classical physics (general relativity being a classical theory), the minimal shape of the singularity that can support these properties is instead a 2D ring with zero thickness but non-zero radius, and this is referred to as a ringularity or Kerr singularity. [957]

This rotation is called frame dragging meaning the spacetime frame is dragged into the blackhole. A rotating mass generates angular momentum. But since spacetime is what is actually rotating, anyone caught in that rotation would not experience the angular momentum. Our universe could be swirling around in an ergosphere, and it would feel no different than it does now.

The ring singularity of a Kerr black hole is a gravitational singularity that is shaped like a ring and is located at the equatorial kink of the inner ergosphere.

> The region just outside the event horizon of a rotating black hole (i.e. a Kerr black hole), within which an observer is forced to rotate with the black hole, and cannot remain stationary with respect to the rest of the Universe. The outer boundary of the ergosphere is the static limit. In a non-rotating Schwarzschild black hole, the event horizon and stationary limit coincide. The ergosphere derives its name from the fact that energy can be extracted from the black hole in this region via the Penrose process (the prefix 'ergo' means 'work'). [958]

When a spherical non-rotating body of a critical radius collapses under its own gravitation under general relativity, theory suggests it will collapse to a 0-dimensional single point. However, this is not the case with a rotating black hole (a Kerr black hole). With a fluid

rotating body, its distribution of mass is not spherical (it shows an equatorial bulge), and it has angular momentum. Since a point cannot support rotation or angular momentum in classical physics (general relativity being a classical theory), the minimal shape of the singularity that can support these properties is instead a 2D ring with zero thickness but non-zero radius, and this is referred to as a ringularity or Kerr singularity. Here is a bit of my own, unenlightened I am sure, speculation.

A rotating hole's rotational frame-dragging effects, described by the Kerr metric, causes spacetime in the vicinity of the ring to undergo curvature in the direction of the ring's motion. Effectively this means that different observers placed around a Kerr black hole who are asked to point to the hole's apparent center of gravity may point to different points on the ring. [959] There is some evidence to suggest that not only everything inside the universe spins like particles, blackholes, galaxies, etc. but that the universe as a whole might spin. [960] Who knows, if us and the universe are living inside a blackhole, we might look up in the sky and see no center, no Big Bang singularity where it all started. And as I mentioned there is a two-dimensional ring singularity center with no thickness. Could this be like the two-dimensional event horizon with a three-dimensional complementarity we think of as spacetime. In quantum gravity, this is called the holographic principle. This will be discussed in the next major section entitled, "The Holographic Big Bang." I will get into more detail in that section, but a fundamental mathematics of relativity is called de Sitter space, which can be three-dimensional, and a fundamental mathematics of quantum mechanics is called Conformal Field Theory, which can be two-dimensional. Therefore, like the hologram, a two-dimensional object can look like a three-dimensional volume. Actually, they are complementary just like the wavicle and many other phenomena I have discussed so far. Could this be the classical and archetypal advent of binary dualism? Could we, the universe, have Being in a Kerr blackhole we call the Big Bang? But then all that gets blown

away by the quantum wave function which has an ontological/ epistemological haziness in spookiness. The philosophical question is how far do we respond to radical externality already imposed on us? That is absolutely and uniquely our singular responsibility. Is information simply data? Is artificial intelligence coupled with quantum computing simply a new and improved mouse trap? Has our history quashed information down into a two-dimensional absolute like a ring singularity? Is classicism's narrative the 'be all in all'? I, me, my body, mind, everything I think of as self is an entangled and decohering system, incessantly entangling and decohering with other systems. Is choice the zenith of each one of us in the observer effect where karma is the branch we create, the branch we live and move and have our being in? What does all this mean for the wave function, nonlocality and entanglement, the observer effect, and information?

Blackhole Information

Most physicists nowadays believe that blackholes are not 'eternal'. Over vast periods of time blackholes dissipate like morning mist on a hot summer day. Poof, they return to nothing. Stephen Hawking first discovered that blackholes emit radiation back into the universe during the course of their lifetime. This radiation is called Hawking radiation. Hawking radiation is actually a form of entropy called von Neuman entropy.[961] Eventually, the loss of this radiation as heat would cause the blackhole to evaporate over a long period of time. Over many years blackholes devour everything in sight leading to increased Hawking radiation but eventually they reach a half-life called the page curve when the blackhole starts to evaporate and Hawking radiation starts to dwindle down. The Page curve tracks entropy over the course of the lifetime of the blackhole. Initially, entropy increases with the increase in Hawking radiation. At the half lifetime point of the Blackhole called the Page time, Hawking radiation decreases, and entropy decreases as the

blackhole evaporates.

Because of this the requirement of the Conservation of Energy is satisfied. But then there is another problem. From the previous discussion we know that quantum mechanics requires that information cannot be lost. However, Hawking believed that this radiation had no additional information about what went into the blackhole. This meant that Hawking's initial position was that information was lost in a blackhole.[962] This would have invalidated the Conservation of Quantum Information requirement which is central to quantum physics. This dilemma was called the 'information paradox'. Even more, the time dependent Schrödinger equation is an axiom of quantum physics. It has a **unitary** time evolution operator which is a fancy way of saying that it requires a certain kind of consistency over time, namely that that evolution preserves the inner products of the Hilbert space, an essential mathematics used in quantum physics. [963] The loss of the unitary requirement of quantum physics and we would have been back to the drawing board on quantum physics. Loss of the unitary would also imply a violation of the Conservation of Energy.

As has been mentioned, there are entangled particles leaking out of the blackhole which are entangled with particles inside the blackhole. The total amount of entangled for a black hole at any given time in its lifetime is called entanglement entropy. At the very beginning of the black hole there are no entangled particles as the blackhole is not feasting yet which means the entanglement entropy is zero. As the blackhole takes in increasingly spacetime along with whatever matter falls in, it falls in as complete, entangled systems. Therefore, the entangled entropy begins to grow within and outside the blackhole. However, at the Page time the blackhole has reached its information limit where no more information can be taken in. At the Page time the blackhole stops swallowing spacetime and starts spitting it back out again as perhaps some form of Hawking radiation. Could this be dark energy? Could this be the transition from a blackhole to a white hole? How would a wormhole fit into

this scenario? What about the information within the blackhole? Specifically, where is it? Intuitively we think it is in some location in some space somewhere. There is an absolutely wild and crazy, Alice in the rabbit hole answer to these questions. Let's start to get into these questions

Hawking initially believed that the only information in this radiation which could be retained was total mass, electric charge, and angular momentum of the initial state. Since many states could be described by total mass, electric charge, and angular momentum in radiation, this necessarily meant that unique, unitary, information was not retained by a blackhole or simply - information was lost. Hawking believed that blackhole radiation had no useful information.[964] Susskind and others were successful in proving that information was not lost in a blackhole but stored at the event horizon of the blackhole. Remember the no-cloning rule of quantum mechanics? This tells us that copies cannot be made of quantum particles. But entangled particles are not copies, they are spookily the same particle and not the same particle. Since entanglement is *the characteristic trait of quantum mechanics* anything which falls into the blackhole, including spacetime itself falls in as complete entangled systems which are both on the inside of the blackhole and on the outside of the blackhole. Entanglement is oblivious to spacetime so the blackhole cannot destroy entanglement.

> So, here is the new dilemma: general relativity tells us that information should fall straight through the horizon toward the deep interior of the black hole. On the other hand, the principles of quantum mechanics tell us that the same information must remain outside the black hole. And the No Cloning Theorem assures us that only one copy of each bit is possible. That's the confusing situation that Hawking, 't Hooft, and I found ourselves in. By the early nineties the situation had reached a crisis: who is right? The observer on the outside who expects the rules of quantum mechanics to

> be respected? For him the bits of information should be located just above the horizon, where they are scrambled and then sent back out in the Hawking radiation. Or is the observer who falls through the horizon correct in expecting the bits to accompany her into the heart of the black hole? [965]

The answer is both, complementarity. But there was still another problem.

As I mentioned earlier, Hawking radiation is information, but it is heat or highly chaotic, impenetrably encoded information. But in order for whatever went into the blackhole to be transformed into heat something had to happen on the way in to convert the information from what we think of as more organized matter or quanta into more disorganized matter or quanta as heat. The problem is that the event horizon was traditionally thought of as smooth. The transition through the event horizon was thought of as simply spacetime and everything in it simply blinking out, not heating up. Traditionally, this problem was explained as a clock, time problem from general relativity. As previously mentioned, anyone entering a blackhole from our relative frame would go slower and slower from time dilation. We would never actually see them hit the event horizon. So, the thinking was that whatever happened to them at the event horizon would never reach us due to them forever approaching the limit of the speed of light. However, they got transformed into radiation or heat we would never be able to see.[966] General relativity tells us that only due to our relative frame of reference information appears to be lost. Well, that worked for a while but nowadays something even more mind bending is being proposed.

Almost the entire interior of the blackhole is referred to as the island.[967]

The issue begins with the end of the pairing of the two

> particles straddling the event horizon. Despite being separated, they maintain a quantum union that transcends space and time—they are connected by entanglement.[968]

When entangled pairs of particles are separated at the event horizon, they pull the energy of zero-point energy, the entangled vacuum of space, with them. Not only is mass from entangled systems going into a blackhole but the entangled vacuum background, the fabric, the glue, of spacetime itself, is being pulled into the blackhole as well. And it all goes in as a completely entangled system. The entangled vacuum energy particles are the ones which actually get radiated back into space as Hawking radiation. This drains the blackhole of energy as these particles are emitted back into space. All of the entangled systems remain on the event horizon and also go into the blackhole island. Since entangled systems know nothing about spacetime they remain entangled at the event horizon and the island. Normally, pairs of virtual particles are pulled out of zero-point energy in pairs of matter and antimatter making them annihilate each other as soon as they become non-virtual. However, at the event horizon of a black hole the entangled systems as anti-matter gets pulled into the island and the other entangled systems of matter become Hawking radiation. The anti-matter has negative energy which depletes the blackhole of positive energy fulfilling the conservation of energy requirement. But what about the conservation of information requirement?

The first thing to know is that information is not some abstract concept of what a ‘thing’ is. Information is both epistemological and ontological. Information hovers strangely between ideal and real, potential and actual, in our colloquial vocabulary. But it definitely has a non-local place in spacetime. There is a limit to how much information can be contained in the very volumes of non-local space. The bottom line is that the maximum theoretical limit of information which can be for one centimeter cubed of volume is 10^{66} bits of data.

To cut a long story short the maximum information that you can store in 1 $cm^3 = 10^{-6}$ m^3 of space is proportional to the area of its boundary. For a uniform spherical volume, that area is: $A = V^{2/3} = 10^{-4}$ m^2

Therefore, the maximum information (number of bits) you can store is approximately given by: $S \sim A/A_{pl}$ where A_{pl} is the Planck area $\sim 10^{-70}$ m^2. For our 1 cm^3 volume this gives $Smax \sim 10^{66}$ bits.[969]

But every volume has a boundary and as I already discussed the surface area of the boundary of a geometric shape is proportional to its volume. A 'voxel' is a tiny volume of space. Susskind explains surface area and volume like this,

Filling space with voxels is far more costly than filling a surface with pixels. For example, if your computer screen is a thousand pixels on a side, the total number of pixels is one thousand squared, or one million. But if we want to fill a volume of the same size with voxels, the required number would be one thousand cubed, or one billion. (Susskind, 2008, p. 338) [970]

In the case of the blackhole, the limit of information which can be on the inside of a black hole is limited by the surface area of the event horizon. This places a limit on a blackhole's surface area and volume. So, information cannot just keep getting squished down forever. Therefore, any blackhole has a finite informational limit. But where the information is, is another story. Susskind tells us,

But the idea that the location of a bit of information is not necessarily where you might expect is now a widely accepted fact. [971]

The information in a blackhole is both on the inside of the

blackhole and the outside of the blackhole. In other words, exformation is non-local. The inside is non-locally mapped to the outside.[972] The idea of 'inside' and 'outside' is an idea of convention not fact. Since entanglement is non-local in terms of spacetime entangled systems, this would mean inside and outside are misleading concepts. Perhaps one way to think of this is as a wormhole. A wormhole is not 'in spacetime'. It has nothing to do with spacetime. It is as if the 'same' entangled phenomenon (system) is in 'two places' at the same time. In the quantum world, there is no notion of spacetime, universes, linear distance or the passage of time. If blackholes and white holes are complementary, then whatever we see of blackholes in our universe may well be a Big Bang in another universe (or is it the same universe). This means at the most fundamental level; existence is not monoclonal.

Whatever we historically have called 'reality' cannot be duplicated. Neither can it be deleted. It cannot hide. It is absolutely unique. It is always a singularity incapable of repetition except in narrations of branching. It is always cohabitating in a spooky multiplicity which pays no regard to place, to location as we want to think it. This kind of sounds a bit like Leibniz' monad, doesn't it? The bottom line is the inside and the outside of a blackhole are ontologically Zen koans[973] Think about how this might affect our idea of blackhole and white hole. We think of them as two different things. In 'reality' they are the 'same thing'. There is no blackhole with information going in and white hole with information going out. They are one and the same thing. It is merely a matter of perspective. Again, complementarity is still the only answer. There is no rising above in terms of Concept. There is no unity or higher order which can reconcile or account for complementarity. The entire history which sought to explain origin in terms of bipolarities of rationality/irrationality, sanity/insanity, logic/contradiction, presence/absence, rule/ruled, and authority/powerless is upended by quantum physics. Exactly what is inside a blackhole is up for grabs, but we know that whatever goes inside a blackhole is highly

entangled information.

Blackholes and Exformation

At the singularity of a blackhole, there is no spacetime but there is still exformation. Remember, exformation does not care so much about spacetime except as an emergent phenomenon. What physicists have discovered is that the two-dimensional area of the event horizon of the blackhole is what determines how much stuff you can put in the three-dimensional volume of the blackhole. This has to do with the blackhole's entropy. Remember entropy has an inverse relationship to information.[974] Entropy is a measure of informational uncertainty. If we know the amount of entropy in a system, we can calculate an average level of how much surprise or uncertainty is in the system.[975] All of this will be discussed in more detail in the section on the holographic principle.

> One of the most exciting aspects of the progress in the blackhole information paradox is that it points toward a more general understanding of the holographic principle, which previously had been made precise only in situations very different from our real universe. In the calculations from 2019, however, the way the information inside of the blackhole is encoded in the Hawking radiation is mathematically analogous to how a gravitational system is encoded in a lower-dimensional nongravitational system according to the holographic principle. And these techniques can be used in situations more like our universe, giving a potential avenue for understanding the holographic principle in the real world. A remarkable fact about cosmological horizons is that they also have an entropy, given by the exact same formula as the one we use for blackholes. The physical interpretation of this entropy is much less clear, and many of us hope that applying the new techniques to our universe

> will shed light on this mystery. If the entropy is measuring how much stuff you can stick beyond the horizon, as with blackholes, then we will have a sharp bound on how much stuff there can be in our universe.[976]

Information going inside that blackhole and retained at the event horizon and Hawking radiation are highly entangled. Also, remember that in cosmology the Big Bang emerged from a singularity. Clearly, we can see in cosmology that the Big Bang's singularity entanglement is prior to spacetime. In the Big Bang singularity, spacetime emerges from entanglement, and we know that exformation is retained. Can we assume that there was something not our time which we cannot think was 'prior' because time only occurred after the Big Bang. Could it be that encoded exformation was spookily actualized after the Big Bang? We know that a black hole is a doorway to an unaccounted-for exteriority which faces our universe in the event horizon. Its interiority exceeds anything we can possibly call our universe. Yet, there is an information requirement which somehow gets satisfied by exformation, highly entangled and chaotic, without origin, exformation.

> Particle pairs [entangled particles] that straddle the event horizon of a blackhole, however, become forever separated from each other. The newly divorced particles peel away from the horizon in opposite directions, with one member crashing into the singularity and the other escaping the blackhole's gravitational pull in the form of Hawking radiation. This process is draining for the blackhole, causing it to get lighter and smaller as it emits energy in the form of the outgoing particles. Because of the law that energy must be conserved, the particles trapped inside must then carry negative energy to account for the decrease in the total energy of the blackhole.[977]

But isn’t there a difference between a blackhole and our universe where our laws of physics no longer apply? Spookily, our outside and inside is from our complimentary perspective. Therefore, why would outside and inside apply to the interior of a blackhole? Since it does not apply, what are the implications of our outside and inside?

> There is a crucial difference between cosmological and blackhole event horizons, however. In a blackhole, spacetime is collapsing toward a single point—the singularity. In the universe at large, all of space is uniformly growing, like the surface of a balloon that is being inflated.[978]

Could the inside of a blackhole secretly be on the outside? What if all the information as causes and effects, spacetime, quantum wave function informational updates could be transformed to exformation in a singularity? What if all the information which fell into a blackhole was entangled with the information on the outside of the blackhole? This shared information is exformation. It is not in spacetime. What does it mean to think spacetime as emergent from exformation. Our historic approach as cause and effect has the cart before the horse. Do we have it all backwards? What would it mean to think all causes and effects, spacetime, the quantum wave function, as informational updates as emergent from exformation? However, exformation itself is not causal. Exformation culminates chaotically. Spacetime arrives as emergent with encoding and decoding, cause and effect, a unitary time evolution operator.

Well, instead of an outside and an inside to a blackhole or an outside as an event horizon of an expanding universe and an inside as spacetime where we all live and move and have our being, what if outside is inside and inside is outside depending on your perspective? How would outside and inside arise from exformation?

Let's take a step back and think about how we got here. The

> origins of the information paradox can be traced back to the incompatibility between the sequestering of information by the event horizon and the quantum-mechanical requirement of information flow outside the blackhole. Naive resolutions of this tension lead to drastic modifications of the structure of blackholes; however, subtle yet dramatic effects from fluctuating wormholes change everything. What emerges is a self-consistent picture that lets a blackhole retain its regular structure as predicted by general relativity, albeit with the presence of an implicit though powerful nonlocality. This nonlocality is screaming that we should consider a portion of the blackhole's interior—the island—as part of the exterior, as a single unit with the outside radiation. Thus, information can escape a blackhole not by surmounting the insurmountable event horizon but by simply falling deeper into the island.[979]

Instead of us just poof, being here, and the unanswerable question, “What happens to all that stuff that falls into the singularity of a blackhole?” Why not just simply think that exformation at some ancient singularity emerges as the ‘event horizon’, the observable, particle horizon, information limit, from which our spacetime emerges? Ok, classicism has not tutored us to think such a heretic thought, but we already know that classicism just saw the cart and assumed the absolute was pulling the cart.

If we emerge from exformation, would it become less awkward to jettison all the baggage of an idealized classical world with its modernity progeny of five senses, machine based, Frankensteinian patchwork of ‘reality’? Might it be more straight forward to take a fresh look at how ‘reality’ arises as from a quantum wave function collapsed by observing quantum states? Or better, ‘reality’ as branching, probability information updates from quantum observation? Could we call these complementarity dualities exformation? So, emergent spacetime or blackhole singularity, in

effect, ***is*** exformation and so ***is*** the universe. Can we then think of the wormhole as exformation and what is not the wormhole as branching universes? In this case, we do not communicate through the wormhole. The wormhole communicates as us, here now! 'Reality', spacetime, cause and effect, etc. do not get lost in exformation. It is emergent from exformation. It branches as 'us', as observers, spook-'I'-fied from classicism, information updates which harken back to the middle voice - acting and acted upon with reciprocity as emergence, with wonder, beauty, awe which faces us.

Blackhole Complementarity

There is a complementarity to blackholes depending if you are on the outside or the inside of a blackhole.

> Physicists thought they resolved the paradox in 2004 with the notion of blackhole complementarity. According to this proposal, information that crosses the event horizon of a blackhole both reflects back out and passes inside, never to escape. Because no single observer can ever be both inside and outside the blackhole's horizon, no one can witness both situations simultaneously, and no contradiction arises. The argument was sufficient to convince Hawking to concede the bet.[980]

Looking from the outside, Hawking Radiation is what someone would see emanating from the event horizon of a blackhole. If we saw someone going towards the blackhole event horizon, according to Einstein's relativity, they would move slower and slower until, at the event horizon, they would stop forever. Time would stop at the event horizon from our relative frame perspective. This is Einstein's relativity for time dilation. On the other hand, anyone going into the blackhole would not see anything different until they hit the firewall of the inner horizon at the singularity.

Blackhole Event Horizon

The event horizon of the blackhole is a two-dimensional boundary where our universe ends. The event horizon is a boundary condition which encodes entangled quantum information of everything that went into the interior of the blackhole. However, since the information is encoded quanta, it has no gravity component. The interior of the blackhole is what gives the blackhole immense gravity.

> Consider a universe encased in a boundary like a snow globe. Apart from having a big wall around it, the interior is basically like our universe: It has gravity, matter, and so forth. The boundary, too, is a kind of universe. It does not have gravity and, being just a surface, lacks depth. But it makes up for that with vibrant quantum physics, and all in all it's exactly as complex as the interior. Different though these two universes may look, they are perfectly matched. Everything in the interior, or "bulk," has a counterpart on the boundary. And even though the geometry of the bulk is unlike the geometry of our own universe, this "AdS/CFT" duality [to be discussed later] has been string theorists' favorite playground ever since Maldacena introduced it.
>
> By the logic of this duality, if you have a blackhole in the bulk, it has a simulacrum on the boundary. Because the boundary is governed by quantum physics without the complications of gravity, it unequivocally preserves information. So must the blackhole.[981]

Effectively, this means that the blackhole retains all the information it acquired and more importantly, no information is lost. Let's take a deeper look at what happens if we are watching an object fall into a blackhole from afar. From our relative frame something which moves towards the event horizon of a black hole

slows down increasingly due to time dilation. At the event horizon time stops so whatever hit the event horizon would also stop. We would never see anything fall into the event horizon. Only the exformation of what fell in would be retained at the event horizon.

Does an object approaching the event horizon of a blackhole ever actually breach the event horizon from the point of view of observers far outside of the blackhole?

This is a fantastic question, and the answer highlights some of the most counterintuitive aspects of the theory of general relativity. The short answer is no, but let's delve deeper into a few of the strange things that happen when objects approach the speed of light.

To an outside observer, as an object falls toward the event horizon (the point of no return where not even light can escape the gravitational pull of a blackhole), two effects come into play. As light leaves the high gravitational field surrounding the blackhole and reaches the observer — who is in a lower gravitational field — it loses energy. So, because light becomes more red at lower energies, the object seems to get redder and redder as it approaches the event horizon.

In addition, general relativity predicts that when an observer in a low-gravity environment observes an object in a high-gravity one, the observer will see time pass more slowly for the object. This slowing means that the light emitted by the falling object will be spread out over a much longer time. If you reduce the rate at which light is emitted, it will appear dimmer and dimmer. From the observer's point of view, as the object approaches the event horizon, time will slow to the point where it will take longer than the lifetime of the universe for the object to emit individual photons.

Thus, as an object falls toward the event horizon of a blackhole, it will redden in appearance. It will also appear to emit light more slowly, and thus will become dimmer. The

> combination of these two effects are that an external observer will see the object redden and fade out of sight, but they will never see it cross the event horizon.[982]

From our perspective outside the blackhole looking towards the event horizon of the black, we would see spacetime slowing down until it stopped at the event horizon and Hawking radiation matriculating out. Hawking radiation is highly encoded information about what went in the event horizon as well. The bottom line is that information is preserved from the perspective of our universe. However, from the perspective of someone that fell into the event horizon all information that fell in with them including themselves would slip in as if nothing changed. At least, until they approached the inner horizon of the singularity. So, which is it? Did information matriculate out or did it go in the Blackhole? The answer is both due to complementarity.

> Blackhole complementarity is the new kind of complementarity that results from combining quantum mechanics with the theory of gravity. There is no single answer to the question, "Who is right? The observer who remains outside the blackhole and sees all information radiated from just above the horizon? Or the observer who falls through with the bits that are heading toward the center of the blackhole?" Each is right in its own context: they are complementary descriptions of two different experiments. In the first the experimenter stays outside the blackhole. He may throw things in, collect photons as they come out, lower probes down to just above the horizon, observe the effects on the trajectories of particles passing near the blackhole, and so on.
>
> But in the second kind of experiment, the physicist prepares an experiment in her lab. Then, lab and all, she jumps into the blackhole, crossing the horizon, while

performing the experiment.

The complementary descriptions of the two experiments are so radically different that it hardly seems credible that they could both be right. The external observer sees matter fall toward the horizon, slow down, and hover just above it. The temperature just above the horizon is intense and reduces all matter to particles, which are finally radiated back out. In fact the external observer, monitoring the in-falling observer, sees her vaporized and reemitted as Hawking radiation.

But this is nothing like what the freely falling observer experiences. Instead she passes safely through the horizon without even noticing it. No bump or jolt, no high temperature, no warning of any kind signals the fact that she has passed the point of no return. If the blackhole is big enough, let's say, with a few million light-year radius, she would sail on for another million years with no discomfort. No discomfort, that is, until she reaches the heart of the blackhole, where tidal forces—the distorting forces of gravity —eventually become so strong that . . . never mind, it's too gruesome.

Two such different descriptions sound contradictory. But what we have learned from Bohr, Heisenberg, and others after them is that apparent paradoxes of this type signal genuine contradictions only when they lead to conflicting expectations for a single experiment. There is no danger of incompatible experimental results because the freely falling observer can never communicate her safe passage to the outside. Once she has safely passed the horizon, she is permanently out of contact with all observers who remain outside the blackhole. Complementarity is strange but true.

The other major revolution of the early twentieth century was Einstein's Theory of Relativity. Certain things are relative to the state of motion of the observer. Two different

> observers moving rapidly past each other will disagree about whether two events occurred at the same time. One observer might see two flashbulbs flash at exactly the same time. The other would see one flash take place before the other. The Principle of Blackhole Complementarity is also a new and stronger relativity principle. Once again the description of events depends on the state of motion of the observer. Remaining at rest outside the blackhole, you see one thing. Falling freely toward the interior of the blackhole, you see the same events entirely differently.
>
> Complementarity and relativity—the products of the great minds of the early twentieth century—are now being united in a radically new vision of space, time, and information. 983

However, because the exformation is highly entangled, one quantum system of everything that went in is retained in our universe by the event horizon and Hawking radiation and the other copy of the entangled system of everything that went in is lost to our universe in the singularity. Additionally, since exformation is prior to spacetime, the blackhole has simply converted spacetime to exformation and retained one copy in our universe and another in the singularity with no exformation getting lost.

Normally, due to the Second Law of Thermodynamics, entangled systems undergo change increase in entropy. Another way to think about this is that the encoded exformation gets more chaotic. This is called information entropy. In 1948 Claude Shannon introduced the concept of information entropy also referred to as Shannon entropy. Shannon was referring to data communication over a communication channel like twisted pairs of phone lines. Shannon showed that the amount of noise or entropy in a communication was directly related to how much lossless information could be sent from one side of the channel to the other. This theorem was useful in that it allowed engineers to understand how much compression

of data was needed to get lossless information through the channel and the amount of error correction that would be required.[984] But noise in a communication channel is also encoded information about everything in the environment of the communication channel, the pipe. Therefore, characterizing the pipe in real time would allow algorithms to utilize different parts of the frequency spectrum to get useful information through the pipe. The communication channel is similar to entangled systems with the exception that there is no pipe since there is no spacetime only exformation. This implies that as one entangled system in our spacetime undergoes entropy or decoherence any other entangled system in the singularity would also track these entropic changes as well informationally. Recall that information is not lost. However, the entangled system which is no longer part of our universe no longer contributes to entropy in our universe. Therefore, due to Hawking radiation emanating back into our universe from the event horizon, over time, the entropy of the blackhole would decrease.

> Hawking radiation reduces the mass and rotational energy of black holes and is therefore also theorized to cause black hole evaporation. Because of this, black holes that do not gain mass through other means are expected to shrink and ultimately vanish.[985]

However, the problem is if entropy decreases in entangled particles, it is no longer increasing or staying the same. This implies that over very vast periods of time the blackhole would reach a halfway point where it would start to dissipate completely releasing all the exformation back into the universe.

> The irony is that Einstein himself is in a superposition of being both wrong and right. He was right to recognize the importance of entanglement in distinguishing quantum mechanics from classical physics. What he got wrong can be

summed up with the truism “correlation does not imply causation.” Although the fates of the particles are inextricably correlated, the measurement outcome of one does not cause the outcome of the other. It turns out that quantum mechanics simply allows for a new, higher degree of correlation than we are used to.

To consider the quantum nature of spacetime, we relied on a technique designed by Richard Feynman called the path integral of quantum mechanics. The idea is based on the weird truth that, according to quantum theory, particles don't simply travel along a single path from point A to point B—they travel along all the different paths connecting the two points. The path integral is a way of describing a particle's travels in terms of a quantum superposition of all possible routes. Similarly, a quantum spacetime can be in a superposition of different complicated shapes evolving in different ways. For instance, if we start and end with two regular black holes, the quantum spacetime within them has a nonzero probability of creating a short-lived wormhole that temporarily bridges their interiors.

Including this potential effect of wormholes produces a new formula for the entanglement entropy of the radiation when applied to a single copy of the system. Instead of Hawking's original calculation, which simply counts the number of Hawking particles outside a black hole, the new formula curiously treats the island as if it were outside and a part of the exterior Hawking radiation. Therefore, the entanglement between the island and the exterior should not be counted toward the entropy. Instead the entropy that it predicts comes almost entirely from the probability of the swap actually occurring, which is equal to the area of the boundary of the island—roughly the area of the event horizon—divided by Newton's gravitational constant. As the black hole shrinks, this contribution to the entropy decreases.

This is the island formula for the entanglement entropy of the Hawking radiation.

The final step in computing the entropy is to take the minimum between the island formula and Hawking's original calculation. This gives us the Page curve that we've been after. Initially we calculate the entanglement entropy of the radiation with Hawking's original formula because the answer starts off smaller than the area of the event horizon of the black hole. But as the black hole evaporates, the area shrinks, and the new formula takes the baton as the true representative of the radiation's entanglement entropy.

What is remarkable about this result is that it solves two paradoxes with one formula. It appears to address the "firewall" paradox by supporting the option of nonlocality that my AMPS group originally dismissed. Instead of breaking the entanglement at the horizon, we are instructed to treat the inside—the island—as part of the outside. The island itself becomes nonlocally mapped to the outside. And the formula solves the information paradox by revealing how black holes produce the Page curve and preserve information.

Let's take a step back and think about how we got here. The origins of the information paradox can be traced back to the incompatibility between the sequestering of information by the event horizon and the quantum-mechanical requirement of information flow outside the black hole. Naive resolutions of this tension lead to drastic modifications of the structure of black holes; however, subtle yet dramatic effects from fluctuating wormholes change everything. What emerges is a self-consistent picture that lets a black hole retain its regular structure as predicted by general relativity, albeit with the presence of an implicit though powerful nonlocality. This nonlocality is screaming that we should consider a portion of the black hole's interior—the island—as

part of the exterior, as a single unit with the outside radiation. Thus, information can escape a black hole not by surmounting the insurmountable event horizon but by simply falling deeper into the island.

Despite the excitement of this breakthrough, we have only begun to explore the implications of spacetime wormholes and the island formula. Curiously, while they ensure that the island is mapped onto the radiation, they do not generate a definite prediction for specific measurements of the Hawking radiation. What they do teach us, however, is that wormholes are the missing ingredient in Hawking's original estimation of the randomness in the radiation and that gravity is in fact smart enough to comply with quantum mechanics.

Through these wormholes, gravity harnesses the power of entanglement to achieve nonlocality, which is just as unnerving to us as the entanglement that originally spooked Einstein. We must admit that, at some level, Einstein was right after all.[986]

Problematically, it also means the second law of thermodynamics appears to be violated as the entropy of the blackhole decreases. The second law of thermodynamics states that in a closed system entropy will always increase until thermal equilibrium is obtained or stay the same when thermal equilibrium is obtained, but entropy can never decrease in a closed system. Complementarity is one thing for a physicist, but violating the second law of thermodynamics is a mortal sin.

As part of the work, they discovered that the universe undergoes a baffling rearrangement. At the outset, the blackhole is at the center of space and the radiation is flying out. But after enough time has passed, the equations say, particles deep inside the blackhole are no longer part of the

hole anymore, but part of the radiation. They have not flown outward, but simply been reassigned.

This is significant because these interior particles would ordinarily contribute to the entanglement entropy between the blackhole and the radiation. If they are not part of the blackhole anymore, they no longer contribute to the entropy, explaining why it begins to decrease.

The authors dubbed the inner core of radiation the "island" and called its existence "surprising." What does it mean for particles to be in the blackhole, but not of the blackhole? In confirming that information is retained, the physicists eliminated one puzzle only to create an even bigger one. Whenever I asked Almheiri and others what it meant, they looked off into the distance, momentarily lost for words.[987]

The entropy of the blackhole in our universe actually starts decreasing due to the release of Hawking radiation. Some have likened the release of Hawking radiation to hair-like follicles which increase over time from our relative frame starting at the event horizon when whatever matter fell in and tracking entropic changes in our universe to the entangled record in our universe. These hair-like follicles we call Hawking radiation may actually be the entropic record of changes starting at the moment an entangled system went into the blackhole to the present. The odd thing about this entropic record is that growing hairs in our universe would still be tracked and encoded pre-spacetime. However, the twin entangled system in the singularity would retain a pre-spacetime record as well of the temporal record but NOT temporally (gee, talk about a Zen Koan). Anyway, by doing this, the Second Law of Thermodynamics would not be violated. [988]

It would seem that whatever was in existence is no more. Out of something comes nothing - reverse Genesis? Even more mind-boggling could the macroscopic blackhole be repeated in every

microscopic qubit of a quantum computer. Could this be how information is retained for entangled particles?

> Theorists in the West Coast group imagined sending the radiation into a quantum computer. After all, a computer simulation is itself a physical system; a quantum simulation, in particular, is not altogether different from what it is simulating. So the physicists imagined collecting all the radiation, feeding it into a massive quantum computer, and running a full simulation of the blackhole.
>
> And that led to a remarkable twist in the story. Because the radiation is highly entangled with the blackhole it came from, the quantum computer, too, becomes highly entangled with the hole. Within the simulation, the entanglement translates into a geometric link between the simulated blackhole and the original. Put simply, the two are connected by a wormhole. "There's the physical blackhole and then there's the simulated one in the quantum computer, and there can be a replica wormhole connecting those," said Douglas Stanford, a theoretical physicist at Stanford and a member of the West Coast team. This idea is an example of a proposal by Maldacena and Leonard Susskind of Stanford in 2013 that quantum entanglement can be thought of as a wormhole. The wormhole, in turn, provides a secret tunnel through which information can escape the interior.[989]

Wouldn't this imply that spacetime arises from exformation which is oddly reminiscent of Leibniz monadology?

> All this reinforces many physicists' hunch that spacetime is not the root level of nature, but instead emerges from some underlying mechanism that is not spatial or temporal. To many, that was the main lesson of the AdS/CFT duality. The new calculations say much the same thing, but without

> committing to the duality or to string theory. Wormholes crop up because they are the only language the path integral can use to convey that space is breaking down. They are geometry's way of saying the universe is ultimately nongeometric.[990]

In 3-D space we have gravitational waves. However, in 2-D boundary conditions there are no gravitational waves but 'gravitational edge modes' which can be thought of as fluctuations on or near the boundary of spacetime. The way I visualize this is as waves moving into shore on the ocean. Farther away the waves look like what we think of as ocean waves. However, when they get close to the beach, they are more like water pulsating forward and backward.

> For AdS/CFT, we have the luxury of numerous explicit constructions. In contrast, there are only a few constructions for dS/CFT. Hikida and colleagues have worked toward constructing new examples of a dS/CFT correspondence. They consider the setting of classical Einstein gravity in 2 + 1 dimensions—this spacetime has one spatial dimension less than our own Universe but is often a touchstone in studies of quantum gravity since there are more mathematical tools available to study it. While in our Universe of 3 + 1 dimensions there are localized gravitational waves, gravity in 2 + 1 dimensions has a different character. In 2 + 1 dimensions, there are no localized gravitational waves but there can be gravitational edge modes, which can be thought of as wave-like fluctuations living on or near the "boundary" of the spacetime.[991]

The article goes on to use a lake analogy which "starts very narrow at the bottom and then expands in width toward the top". At the top surface of the lake "waves on the lake would be

fluctuations".[992]

The starting point for understanding the work of Hikida and colleagues is that classical Einstein gravity in three dimensions can be written as a Chern-Simons theory. This is a topological theory that describes fluctuations near the surface of the spacetime. Many Chern-Simons theories are equivalent to conformal field theories known as Wess-Zumino-Witten (WZW) models. While there is no obvious way to create a correspondence between Einstein gravity and a WZW model, Hikida and colleagues ask whether there is a WZW model that reproduces features of 3D de Sitter gravity. We can imagine such a 3D de Sitter world as a lake that starts very narrow at the bottom and then expands in width toward the top. The surface of the lake would represent a candidate WZW model, and the waves on the lake would be fluctuations in this 2D model.

The researchers focus their attention on "Euclidean" versions of both Einstein gravity and the WZW model in order to study some tractable properties of 3D de Sitter. On the basis of symmetry considerations, Hikida and colleagues look at the family of so-called SU(2)k WZW models indexed by a positive integer k. The size of k usually describes the strength of interactions. By pattern-matching to the AdS/CFT correspondence, the researchers infer that k is equal to -2 plus a small imaginary number, which is peculiar since k is supposed to be a positive integer. Undeterred, Hikida and colleagues follow their intuition and show that for this peculiar k, the WZW theory reproduces features of Einstein gravity, such as the entropy of de Sitter space with a particle in it.

These results are surprising. To explore the robustness of their approach, Hikida and colleagues offer several variations of their equations, which reproduce features of more exotic

theories of gravity. These analyses provide evidence that 3D de Sitter gravity may be equivalent to an unusual 2D WZW theory, which would instantiate a form of the dS/CFT correspondence. Interestingly, this WZW theory does not satisfy the usual rules of quantum mechanics since it is a nonunitary theory. This feature aligns with the dS/CFT vision that de Sitter quantum gravity is equivalent to a non-quantum-mechanical theory.

At present, most of the rules for de Sitter quantum gravity are waiting to be discovered. This search is an exciting challenge, and Hikida and colleagues have made a creative and interesting contribution. While it remains to be seen whether their particular rules will be incorporated into an ultimate theory of nature, it is clear that we must expand our theoretical horizons to understand quantum gravity in our expanding Universe. 993

For me this sounds eerily reminiscent of a way to visualize a blackhole with the singularity "*very narrow at the bottom"* and the event horizon "*expands in width toward the top*" like the top surface of the lake where "*waves on the lake would be fluctuations*". The two-dimensional surface on the event horizon is made by the boundary of the speed of light.

The blackhole is the remnant of a collapsed star that has all of its mass now concentrated in a singularity at the center of the hole. The singularity is surrounded by a surface of finite radius called the event horizon. The event horizon is that surface on which the escape velocity is everywhere equal to the speed of light in free space: 299,792,458 meters per second (approximately equal to 3 times 10^8 m/s).

Like the circle in the plane, the event horizon of a blackhole separates the universe into two disjoint regions: the exterior of the hole and the interior of the hole. Call the

> exterior the known universe-the universe we all inhabit. The event horizon itself is the boundary between the two regions.[994]

Thinking about the tv show called “The Outer Limits,” what if our universe is the inside of a blackhole?

> Our Universe appears to be expanding and cooling, having originated some 13.8 billion years ago in a hot Big Bang. However, it's plausible that what we see from inside our Universe is simply the result of being inside a blackhole that formed from some parent Universe. If the blackholes that form in our cosmos give birth to baby Universes, perhaps we arose from the formation of a blackhole ourselves.
>
> If you add up the mass and energy of all the particles contained within the visible Universe, you can ask the question, “How big would the event horizon of a blackhole with this mass be?” And the answer, perhaps surprisingly, is very close to the actual horizon size of the observable Universe. Additionally, there’s another related idea, made famous by Stephen Hawking, that each time we create a blackhole in our Universe, it could give rise to a “baby Universe” that’s only accessible to an observer that crosses inside that blackhole’s event horizon.[995]

The article referenced in the previous quote has even more evidence that our universe may be the inside of a blackhole. In 1935 Einstein’s field theory equations described something we would call a white hole today. A white hole is the opposite of a blackhole. Instead of pulling all mass and even massless particles like light down into a singularity, a white hole pushes out everything a blackhole pulls in. Could our universe be the white hole of some other universe’s blackhole? Does this fit with ideas of parallel universes or what many ancient traditions thought as

‘many-worlds theories.’ If this were the case, from our side of the event horizon, we would see the white hole as the Big Bang. However, it would seem impossible to ever prove this since, from the interior of the event horizon of a blackhole, any exteriority would not be directly accessible. Nevertheless, could we build a circumstantial case indirectly? Could we extrapolate from the perspective of quantum entanglement and Hawking radiation? Could we have mathematical theories which would go a long way accounting for long standing problems in quantum physics which are reaching an apex of publications in physics research now?

Chaos, Information, Entropy

If chaos can be thought of as the sum of all possible information inclusive of exformation *and* the excess of emergence as novel information, then the wave function prior to collapse or branching into ‘order’ irrevocably exceeds classical chaos which is tied causally to infinites and infinitesimals. Let’s remember that quantum entanglement can happen to systems. Quantum entangled systems have uncertain but probabilistic outcomes. These outcomes are determined by the collapse of the wave function. Therefore, observation can collapse the wave function or possibly spontaneously as other natural processes. The well-known definition of work which gives off heat and in a closed system decreasing entropy in the system is called an engine. An engine is capable of work as it decreases entropy or chaos at the cost of increasing the entropy of its environment.

> Collapse of the wavefunction means a quantum mechanical interaction that will change the energy E, an extra microstate. So, after the "collapse" there is one more microstate introduced into the statistical entropy, (maybe a photon has gone off). Entropy is not defined for one particle, in physics. It is as statistical phenomenon of accumulated

> behavior of quantum dominated interactions to large distances where the quantization is averaged out into the thermodynamic variables, in this case S, entropy. So, collapse/interaction increases entropy.[996]

So, two entangled systems repeatedly observed or measured decrease the entropy of their own environment when one system is measured and perform work – cooling. There is a study I found which I will discuss later in the section entitled "Quantum Measurement Cooling Experiment" which describes a quantum refrigeration engine. As crazy as it sounds, the study I cited finds that these engines can be created by mere observation. Therefore, if we have two entangled systems and we observe a property of the first system, the wave function of the second system will collapse as well and we will decrease the entropy of the second system. The second system will increase the entropy of its ambient environment.

Let's also add to this mystery. Since entangled particles could exist on the opposite sides of the universe, observing the state of one entangled system not only cools off its local environment but performs work in the other entangled system on the other side of the universe. The other system cools its ambient environment exformationally, not through spacetime. Additionally, it does this at the expense of increasing entropy in the universe and heating up the universe to a degree. This is the way a refrigerator or air conditioner compressor works. Now we can see why Einstein called this "spooky-action-at-a-distance".

In his time, Einstein thought there must be a local explanation for entanglement. That has been disproven. This is not action in a local distance but exformation which has no meaning to the words space and time. So, exformation affects space and time, perhaps even creates space and time, but has no dependence on space and time. The intuitive notion of cause and effect turns out to be contingent on the afterglow of exformation, the perception of information interpreted via space and time. Even if space and time

are the effect of exformation, exformation has no cause. To speculate that exformation must have a cause would be purely metaphysical or at least highly theoretical as it would have to take leave of any such notions as prior, subsequent, before, after, etc. In our known universe the speed of light indicates the non-existence of time. From Einstein's relativity, we know that no time means no space since they are the same phenomenon. This appears practically synonymous to me as stating that exformation is uncaused.

Entanglement, Brain, Psychic

Let me say at this point with regard to entanglement that we are not talking about some kind of purely 'psychic' observation. The popular notion of 'psychic' is a conjecture of some forms of popular culture and religious metaphysics. Entanglement is scientifically repeatable and observable. Multiple experiments have verified that one observation determines what another observer will see. The observations are not subject to cause and effect or spacetime. Even more, the results do not persist in spacetime when they are not observed. Entanglement is not an isolated phenomenon. It is the basic trait of quantum physics which holds spacetime together and vastly affects everything around us including our bodies. Religious metaphysics can never make a quantum computer. The human brain is composed completely of quanta. Who can say how quanta constituent of the brain affect its environment? I do not want to be reductionary in the previous statement. Rather, my only intention is to point out what we do not know. Could it be that the quantum interactions of our brain with our environment allow us to have the capacity to form narratives we deem as 'reality'? In this case, the adaptive filter of narratives could be hijacked by interests which would give us pre-defined, scientific methods such as the science of marketing to shape and mold our narratives to benefit the self-interest of others. It seems that religion has historically found ways to accomplish this as well. I can think of no reason capitalism or

communism would not do the same. Ok, I could be paranoid if I were trying to be reductionary, but I only pose this to bring up questions not to give answers.

In any case, when two particles are coherently entangled the 'identity' of a property like the particle's spin is 100% predictable for two observers watching each entangled particle even if they are on the other side of the universe from each other. The action of the first observer collapses the wave function of the entangled particle which immediately (with no time…perhaps the notion of the 'now') changes the behavioral spin that the other observer sees. This holds for other observable properties like position, momentum, and polarization. These measurable and observable properties are called quantum states or qubits.

What I am conveying is that the act of measuring a particular entangled property changes what we might call 'actual reality'. These 'changes' are atemporal and aspatial. When entangled particles or cross currents of waves (i.e., energy fields) are merely observed, energy is released regardless of time or space. The act of observing or measuring determines what is seen for entangled qubits. If the position of an electron is observed, the momentum cannot 'exist' at the same time. It has been shown that this is not a limitation of our knowledge but what actually 'is'. This would be like saying if you jump off a cliff with one observer on the top and another on the bottom, both could either see the trail downward you are taking or the change in your acceleration as you fall but not both. In physics, this is called the basis of the uncertainty principle. The uncertainty principle is fundamental to quantum physics.

There is nothing uncertain about these 'reality' quirks as it has been established physics all the way back to Einstein. The uncertainty principle is the recognition that 'recognition' or measurement changes physical reality with varying degrees of uncertainty. This is not mere 'metaphysics'. It is as real as anything we may think of as 'real'. Because energy is created from the observation of entangled particles, the study I am referencing

creates an ‘engine’ from the mere measurement of entangled particles. This means the Western duality of mind-body, God-substance, physics-metaphysics, real-unreal, existence-nothingness etc. is woefully inadequate. There is an unaccounted-for excess to spacetime, cause-effect from exformation theory which cannot stand under this polarization.[997]

Exformation Surviving Wormhole

In 2013 Juan Maldacena and Leonard Susskind problems with Hawking's idea that information entering a blackhole could never leave the blackhole. This is consistent with general relativity. However, if information entering the black hole leaves the universe forever then information is lost forever. This contradicts a fundamental principle of quantum physics which tells us that information cannot be lost. This contradiction is called the ‘Information Paradox’. There is a fantastic article which is a conversation with Maldacena about this very topic.[998] It was published by the Institute for Advanced Studies in 2018. I highly recommend you read it. Here are some of the more pertinent points.

The information paradox was addressed in 2013 by Maldacena and Susskind in something which is referred to as ER = EPR. These were two papers published by Einstein in 1935. The **E**instein-**R**osen paper dealt with two sheets of spacetime bent over each other, so they were parallel with each other and an Einstein-Rosen bridge (later called a wormhole) between the two. The **E**instein-**P**odolsky-**R**osen paper entitled “Can Quantum-Mechanical Description of Physical Reality Be Considered Complete?” delved into the problem of quantum entanglement. Only a genius like Einstein could have published both of these papers in the same year which would go on to be one of the greatest solutions ever discovered by physics. The answer was ER = EPR. This will be discussed in more detail in the next major section entitled, “The Holographic Big Bang”. In a nutshell. Entanglement and wormholes created spacetime.

Spacetime emerges from quanta and the quantum wave function we call a singularity.

Maldacena remarks that these blackholes exist as auxiliary universes. Even though they are really small they have "*very strongly interacting systems can behave as if they are creating their own universe*". He remarks that it is a theory of the universe in a bottle. These universes exist in a lab in superconductivity. I have called them qubits. Superconductivity is precisely the capability which makes qubits possible. Why? Because at room temperatures entanglement and decoherence are incessantly occurring. But in nature this is not a temporally serial thing. It is better thought of as dualistic phenomenon. They are both happening simultaneously like two sides of the same coin. Here is an example of how we can think about this.

Einstein's general relativity works very well describing bent spacetime, what we call gravity. General relativity describes large objects in the universe. However, when we get very, very small Einstein's theory does not fail. It actually tells us that this funny thing - a mathematical singularity occurs. And this is precisely where the other side of the coin comes into play – quantum mechanics. Quantum mechanics does not play in relativity's spacetime. Quantum mechanics deals with the very small, dynamics between wavicles. Quantum mechanics' space is quantized and granular. Another way of saying this is that it does not play in volume. Quantum mechanics' space is flat like a surface. Quantum mechanics is lumpy while general relativity is smooth. Where general relativity is not smooth and falls off the globe of the earth is like the old idea that the earth was flat. This is general relativity's way of saying, "The earth is flat here". This is where singularities occur in general relativity. General relativity goes to mathematical infinities here. So, the problem is how do we marry these two?

Well, for one, we know they are already married. The singularity of the Big Bang has ample astronomical evidence that the universe started out very, very, small – smaller than Planck sizes. The Planck

size is where gravity begins to have an effect. Gravity is negligible in typical applications of quantum mechanics. If that does not convince you, blackholes are another phenomenon where gravity and quanta play together. Blackholes have extremely high levels of gravity. How if you were to fall in one, you would end up as, to cut to the chase, the quantum wave function. We call that general relativity's singularity. So, both theories play together in nature. We just need to find out how that happens.

In Maldacena's interview he tells us that supercooled quantum computers which, as we know work as qubits, are tiny wormholes. In the interview he goes on to tell us,

> They are the same in the sense that they are governed by the same equations, but they are not the same in other details. In a blackhole that exists in nature, there are other particles, like electrons and photons, forming the ordinary matter that exists around the astrophysical blackholes. This is different than the type of matter that could exist around these other blackholes. What they have in common is that both are described by a dynamical spacetime. In both cases, there is a certain spacetime that can be curved. In both cases, there is this notion of having a horizon, and in both cases, there is a Hawking radiation. 999

Maldacena goes on to tell us bluntly,

> These are black holes that exist in other auxiliary universes, which are very small, relatively small. The interesting thing is that these very strongly interacting systems can behave as if they are creating their own universe. It is a theory of a universe in a bottle. 1000

It seems that the universe, black holes, and quantum computing have something very important to tell us about relativity/quantum

complementarity. Both seemingly irreconcilable theories must play together. And how we observe it makes all the difference. I will go into more detail in the next major section, "The Holographic Big Bang". In that section I will also deal with what Physicists call quantum teleportation. No-thing can survive a trip through a wormhole but exformation can. Exformation as highly entangled information is the domain of the quantum wave function. Quantum teleportation is what qubits do.

Quantum information 'surviving the wormhole' in the context of this book tells us that exformation is exterior to anything and everything we have ever known or thought we knew. I believe that for many of us this may be a stepping off point for releasing our death grip on preconceived ideas of 'reality' and letting something 'other' speak to us in a way that holds many possibilities including how we think of each other. With all this in mind, let's get back into wormholes.

Wormholes

Wormholes are highly theoretical phenomena going all the way back to Einstein's two papers in 1935 which were subsequently termed ER = EPR as discussed at the beginning of this book.

> Wormholes are technically known as Einstein-Rosen bridges (the "ER" part of the equation). Nathan Rosen collaborated with Einstein on a paper describing them in 1935. EPR refers to another paper Einstein published with Rosen in 1935, along with Boris Podolsky. That one articulated quantum entanglement's paradoxical puzzles about the nature of reality. For decades nobody seriously considered the possibility that the two papers had anything to do with one another. But in 2013, physicists Juan Maldacena and Leonard Susskind proposed that in some sense, wormholes and entanglement describe the same thing. 1001

While wormholes are highly theoretical, we know there must be a link between gravity and quanta if for no other reason, gravity first emerged from primordial quanta very early in the Big Bang. A wormhole is a short name for the link between gravity and quanta. So, how could wormholes be created? Several ideas are a magnetic monopole, a quantum computer, supersymmetry in string theory, and exotic matter.

The Magnetic Monopole Wormhole

A magnetic monopole is a magnet with only one pole. Every magnet we have ever seen has two poles, a north and south pole. But there is a theory in quantum physics which tells us that magnetic monopoles are possible. How? It may be that every two-pole magnet we have ever seen is connected by a wormhole. In extreme conditions like the early moments after the Big Bang these poles may not have been connected together creating a magnet with only one pole a monopole. Nevertheless, there has been and continues to be much research designed to look for monopoles as, if they were found, would likely indicate a new elementary particle. [1002]

The Quantum Computer Wormhole

Quantum computers have been used to simulate a wormhole, which is a theoretical tunnel that connects two distant points in space-time. In a recent experiment, physicists were able to create a holographic wormhole using a quantum computer.

> The team, led by Maria Spiropulu of the California Institute of Technology, implemented the novel "wormhole teleportation protocol" using Google's quantum computer, a device called Sycamore housed at Google Quantum AI in Santa Barbara, California. With this first-of-its-kind "quantum gravity experiment on a chip," as Spiropulu described it, she and her team beat a competing group of

physicists who aim to do wormhole teleportation with IBM and Quantinuum's quantum computers. [1003]

The wormhole emerged from quantum bits of information, or "qubits," stored in tiny superconducting circuits. By manipulating the qubits, the physicists were able to send information through the wormhole. However, it's not clear in what sense the wormhole can be said to exist. The experiment explores the possibility that space-time somehow emerges from quantum information, even as the work's interpretation remains disputed. It's important to note that this is a highly complex and theoretical topic, and the experiment is still being debated by experts in the field. While the experiment is a fascinating demonstration of the potential of quantum computing, it's not yet clear whether wormholes can be created in the physical world. [1004]

The Supersymmetry Wormhole

Euclidian space goes all the way back to the ancient Greek mathematician Euclid. It is commonly thought of as three dimensions of space we call height, width, and depth. The dimensions are orthogonal or perpendicular to each other. But these dimensions do not have to be limited to three dimensions. They can be any number of dimensions. Euclidean supersymmetry is a theoretical framework in physics that suggests the existence of a symmetry between particles with integer spin and particles with half-integer spin. It proposes that for every known particle, there exists a partner particle with different spin properties. In supersymmetry, each particle from the class of fermions would have an associated particle in the class of bosons, and vice versa, known as a superpartner. The spin of a particle's superpartner is different by a half-integer. Supersymmetry has various applications to different areas of physics, such as quantum mechanics, statistical mechanics, quantum field theory, condensed matter physics,

nuclear physics, optics, stochastic dynamics, astrophysics, quantum gravity, and cosmology. However, no supersymmetric extensions of the Standard Model have been experimentally verified. [1005]

Supersymmetric wormholes in string theory have initiated a lot of research. According to a recent paper by Astesiano and Gautason, a large family of Euclidean supersymmetric wormhole solutions of type IIB supergravity (10 dimensions with no spins higher than 2) which are asymptotically AdS5 × S5. Asymptotic means the same thing as approaching a limit in calculus like zero degrees Kelvin but never actually getting there. Asymptotic **AdS**5 × S5 is a class of spacetimes in string theory. Anti-de Sitter (**AdS**) space which I have already discussed is asymptotic to **AdS**. Gauged fields are fields which describe the behavior of charged particles. Remember charged particles are bosons which have half spins. So, all this means mathematically we can construct fields which explain the half spin bosons can exist in our spacetime using supergravity in five dimensions which is further truncated to a four-scalar (scalar means simple constants) model. This is a fancy way of saying that that the link between gravity and quanta could happen in five dimensions with a simpler, less detailed model in four dimensions. The solutions are constructed using a source of negative Euclidean energy, which is obtained by considering axion fields. [1006]

Normally, gravity is attractive, but a consequence of negative energy is that gravity could be repulsive. Negative energy is a concept used in physics to explain the nature of certain fields, including the gravitational field and various quantum field effects. In quantum theory, the uncertainty principle allows the vacuum of space to be filled with virtual particle-antiparticle pairs which appear spontaneously and exist for only a short time before, typically, annihilating themselves again. Some of these virtual particles can have negative energy. Negative energy is also associated with black holes. The potential well of a black hole is infinitely deep. Hence, if you put a particle deep enough into the well its binding energy will become bigger than its rest mass, and

the particle will have negative energy. Paul Adrien Maurice Dirac proposed the concept of negative energy in 1928 as a component of the Dirac equation. In this equation, Dirac described how quantum states of positive energy would be offset by negative energy. Negative energy would therefore also mean negative mass. Positive masses attract each other, but with a negative mass, gravity could suddenly become a repulsive force. Quantum theory, however, allows negative energy. [1007]

The bottom line to all this goes back to the mathematics of anti-de Sitter space and conformal field theory which explains how gravity arises from quanta. This is a quantum gravity theory. All of this explains how quantum gravity has a purely mathematical relationship with supersymmetry and the cosmological constant.

The Exotic Matter Wormhole

Exotic matter is a type of matter that behaves in ways that are different from the gases, liquids, or solids that we normally encounter on Earth. It is called “exotic” because it has unusual properties that are not found in ordinary matter. For example, superfluid helium is a type of exotic matter that can climb walls. Wormholes are hypothetical objects that connect two places in the universe by bending space. Exotic materials can be created in laboratories by cooling some materials to very low temperatures. Wormholes have never been found, but if they did exist, they could obey our laws of gravity. Most researchers agree that wormholes require “exotic matter” - stuff that is repelled by gravity, rather than attracted - but some have claimed ways around that problem. However, a report in the 27 July PRL [1008] shows that all wormholes, no matter how cleverly constructed, require exotic matter - a condition that many in the field are already working to satisfy. Exotic matter is a type of matter that could potentially be used to make wormholes, but it is still a topic of research and exploration. [1009]

Tiny Wormholes

It is currently believed that entangled particles may have wormholes between them which could explain why they can share information simultaneously no matter what the distance between them. Think about that! Could tiny Planck sized wormholes we have called Einstein-Rosen bridges permeate the universe in some entangled particles or perhaps every entangled particle? This means very small blackholes permeate The fabric of spacetime! The fabric of spacetime is saturated with entangled interruptions which are prior to space and time, cause, and effect. The locality we inhabit as 'my lived time' and 'my lived space' is our lived locality. Many of the entangled particles in our lived locality are local to us in the metaphysical notion of 'locality' which pervades our Western history. Our experience of entanglement is mostly localized, meaning they are not particles separated by millions of light years in our current spacetime understanding. I have discussed this in previous posts[1010] but the period in the 20th century when Einstein was publishing papers on relativity and quantum entanglement was also a period when Husserl and Heidegger were moving in lock step with these ideas in the budding philosophy of phenomenology. Phenomenology is the philosophy of letting phenomena show itself concretely, not abstractly. It is interesting to note that our word paradigm comes from an ancient Greek word meaning 'to show'. [1011]

Gravity from Wormholes

Planck scale wormholes might be the key to understanding spooky entanglement which is pre-spacetime. We have already seen that our classical notions of 'what is' given by the history of classical science and philosophy abandoned the archaic notions of *phusis*. The quantum wave function has no place to rest its head in our history. It finds no eternal abode for Being, no absolute Concept for

‘reality’. Now, even modernities spacetime mechanisms are provincial. They arise from some spooky, something which is not spacetime and neither is it that ‘not’ of spacetime.

> Anyway, the wormhole structure of space–time could in principle be characterized by the extended Heisenberg principle through a deep study of the wavefunction collapse of entangled particles and reveal possible scenarios of QG and cosmology or emergent gravity theories where the exchange of a virtual graviton could also be interpreted in terms of entanglement. At Planck scales wormhole connections would avoid the gravitational collapse and singularities. Moreover, the exchange of a virtual graviton would become equivalent to a wormhole connection and/or entanglement between two or more events. From this we can argue that the ER = EPR conjecture alone, as it is, cannot fully explain without experimental results whether Planck-scale phenomenology can be revealed through entanglement or that gravity and space–time are emergent physical quantities. 1012

In 1935 Einstein’s monumental two papers on the Einstein Rosen bridge (wormhole) and the Einstein-Podolski-Rosen paper on the spooky action of entanglement those two kernels of genius became the mantra of quantum gravity with ER = EPR of the holographic principle. The holographic principle in physics is the idea that the three-dimensional curvature of spacetime described by general relativity is a quantum system of particles in two dimensions. Therefore, the two dimensions of the quantum particles project the three-dimensional image of spacetime just like a hologram works. We know that blackholes produce a lot of spacetime curvature which we call gravity. If Einstein was correct and some blackholes are connected with the Einstein Rosen bridge (wormhole) and spooky action at a distance, entanglement, is a hallmark of

wormholes as physicists now believe,

> Maybe a wormhole links every entangled pair of particles in the universe, forging a spatial connection that records their shared histories. Maybe Einstein's hunch that wormholes have to do with particles was right. [1013]

Therefore, if the fabric of entangled spacetime quanta is permeated with tiny blackholes, they might also produce much lesser amounts of detectible gravity. [1014] This would confirm the wormhole theory and quantum gravity. So, could a wormhole be created in a lab?

> Essentially, entanglement involves two particles, each occupying multiple states at once — a condition referred to as superposition. For example, both particles may simultaneously spin clockwise and counterclockwise. But neither has a definite state until one is measured, causing the other particle to instantly assume a corresponding state. The resulting correlations between the particles are preserved, even if they reside on opposite ends of the universe.
>
> But what enables particles to communicate instantaneously—seemingly faster than the speed of light—over such vast distances?
>
> Now an MIT physicist looking at entanglement through the lens of string theory has proposed an answer: the creation of two entangled quarks—the building blocks of matter—simultaneously gives rise to a wormhole connecting the pair. [1015]

In spacetime the speed of light is absolute. Nothing can go faster than the speed of light *in spacetime*. But if locality is violated by the spooky action of entanglement a 'wormhole' can be visualized as a vehicle in which nonlocality permeates all our narratives of

‘reality’. In this book entangled information is exformation. If exformation underlies, gives rise to spacetime, then our classical notions about spacetime result from the history of ‘observer effects’, more or less entangled systems incessantly cohering and decohering with endless entangled systems in complexities which emerge from beyond the limit of classical chaos or in simpler terms the determinism of the butterfly effect and initial conditions. Classical chaos becomes a limited case, a complementary example, of something far stranger. Classical chaos disappears into quantum chaos through the mists of complexities which make the Gordian knot look like a bowtie (unless you are LaPlace’s demon). But let’s get practical.

According to a study by Julian Sonner, a senior postdoc in MIT’s Laboratory for Nuclear Science and Center for Theoretical Physics, the creation of two entangled quarks simultaneously gives rise to a wormhole connecting the pair. 1016 This theoretical result is based on the concept of string theory and the idea of holographic three-dimensional space, which is used to derive a more complex dimension from the next-lowest dimension. The study suggests that the laws of gravity holding together the universe may not be fundamental but arise instead from quantum entanglement. If you think about it, the only way for exformation, entangled information, to ‘exist’ would have to involve a wormhole-like connection of some type.

Some physicists in November of 2022 at the California Institute of Technology performed an interesting experiment. The idea of the experiment was, could get enough qubits together to produce a trace amount of gravity? Since quanta must give rise to spacetime curvature and blackhole wormholes certainly are both exformation, entangled information, and produce gravity, why not try to produce a tiny wormhole with qubits and look for the effects of gravity from the tiny wormhole? This would prove the essence of ER = EPR. The final result appeared to be a success.

> The wormhole emerged like a hologram out of quantum bits of information, or "qubits," stored in tiny superconducting circuits. By manipulating the qubits, the physicists then sent information through the wormhole, they reported today in the journal Nature.
>
> The team, led by Maria Spiropulu of the California Institute of Technology, implemented the novel "wormhole teleportation protocol" using Google's quantum computer, a device called Sycamore housed at Google Quantum AI in Santa Barbara, California. With this first-of-its-kind "quantum gravity experiment on a chip," as Spiropulu described it, she and her team beat a competing group of physicists who aim to do wormhole teleportation with IBM and Quantinuum's quantum computers.
>
> When Spiropulu saw the key signature indicating that qubits were passing through the wormhole, she said, "I was shaken." [1017]

But we need to take a deeper dive into the specifics of the experiment.

Google's 54-qubit Sycamore chip is entangled. This means that the chip could potentially house a holographic architecture between its entangled qubits. The Sycamore chip might be able to create a tiny wormhole, share exformation, and produce a tiny amount of gravity. The first problem to be addressed with this idea was how would you know if a wormhole was actually created? The solution is called the SYK model after its inventors Subir Sachdev, Jinwu Ye, and Alexei Kitaev. Qubits entangle exponentially not with simple addition as in standard computer bits. But in order to produce any detectible gravity it was thought that it would take many more thousands of qubits than the Sycamore chip provided. This is because the SYK model assumes infinitely many particles coupled to one another with random strengths in four-way interactions. Obviously, the Sycamore chip could not do this. But over many

years of trial and error, tweaking error correction code, compressing overhead, and optimizing coding the experimenters figured out a way they believed might accomplish the task. How did they do this?

It involves having two sets of seven qubits where both sets are entangled. So, there is a left set of seven qubits and an entangled right set of qubits. An eighth qubit is swapped with one of the qubits in the left set of seven qubits. The new information spreads in the left set of seven qubits. A magnetic pulse rotates the left set of qubits which causes a negative-energy shockwave to be sent to the right set of seven entangled qubits. The new information on the right entangled set of seven qubits reflects the swapping of the original qubit and the energy shockwave it received by rotating the left set of qubits. This causes the new information received by the right set of qubits to "*un-spread… "like chaos run backward," and refocuses at the site of a single particle on the right — the entangled partner of the left-hand particle that was swapped out. Then the qubits' states are all measured.*" [1018] The measure on the right qubits due to classical state reduction after many statistical measurements reveal whether or not the swapped qubits teleported or not through the wormhole. The final result is that mathematically it should prove a wormhole had been created using the holograph principle. The SYK model allows particles to interact in groups of four which can mathematically be mappable to a one-dimensional space in something called anti-de Sitter space.

> The researchers look for a peak in the data that represents a difference between two cases: If they see the peak, it means qubit rotations that are dual to negative-energy pulses are allowing qubits to teleport, whereas rotations in the opposite direction, which are dual to pulses of normal, positive energy, don't let qubits through. (Instead, they cause the wormhole to close.) [1019]

As I will discuss, the hologram principle is the union of anti-de Sitter mathematics for three-dimensional space (de Sitter, the 'not' of anti-de Sitter, is used extensively in general relativity) and Conformal Field Theory for two-dimensional quantum mathematics. Put more simply, the wormhole has two 'mouths'. The mathematics at each mouth where spacetime information enters is one more dimension than the mathematics between the mouths. For example, the volume of the blackhole is perfectly encoded and correlated with the surface area of its horizon. In other words, the boundary conditions at a surface encode in its volume or shape what is allowed 'to be'. This applies to informational as well. This also enables wormholes to short-circuit spacetime with exformation but without going faster than the speed of light which is impossible. So, the very geometry of the holographic principle short-circuits spacetime creating something we call gravity.

> The holographic principle says that the two realities — the one with the wormhole and the one with the qubits — are alternate versions of the same physics, but how to conceptualize this kind of duality remains mysterious. 1020

Some cosmologists have even speculated that the entire universe may be a hologram. Cosmologists have explored the intriguing idea that our universe might be akin to a holographic projection. This concept, proposed by Juan Maldacena of the Institute for Advanced Study in Princeton, N.J., suggests that our 4-dimensional spacetime could be a projection from a lower-dimensional reality, much like a 3D hologram emerges from information encoded on a 2D surface. The essence of this idea lies in the AdS/CFT (anti-de Sitter/ Conformal Field Theory) conjecture. It posits that the behavior inside a volume of spacetime with gravity can be understood by studying the quantum-mechanical behavior of particles and fields at that volume's surface, using a theory with one less dimension—one where gravity plays no role. This duality has been used to address

questions about black holes, inflation in the early universe, and even the fundamental nature of spacetime itself. While the notion of a holographic universe is still a topic of debate, it has led to significant discoveries and continues to captivate the minds of physicists.

In fairness this experiment with Google's 54-qubit Sycamore chip was given a lot of credit for its basic idea by physicists, but later physicists found multiple problems with the experiment.

> Now another group of physicists has analyzed the result and determined that, while the experiment may have produced something vaguely wormhole-like, it wasn't really a holographic wormhole in any meaningful sense. In light of the new analysis, independent researchers are coming to doubt that the teleportation experiment has anything to do with gravity after all. 1021

The critique consists of another holographic metaphor, 3D glasses. If we put 3D glasses on while looking at a special 2D image it 'looks' three-dimensional. But is it really?

> But viewed through a holographic lens, the proceedings make perfect sense. The entangled clouds of particles are not a literal wormhole in our universe. But they are dual to a wormhole, meaning that they have a matching behavior for anything a traversable wormhole can do — including transporting a qubit. 1022

The question is not about the holographic wormhole itself but about whether it produces gravity with the 3D lens on. While the experiment may have demonstrated holographic scrambling of information gravitational scrambling of information is believed to be different. While the critiques called the original experiment "wormhole-inspired" they pointed out that in actual observations of

blackholes there is a very characteristic mathematical signature called “size winding” which has to do with the speed of how fast particles fall into a blackhole and the blackhole’s gravitational component. They contend that none of these markers were in the original experiment.

> Here’s the rub: For a definitive showcase of gravitational teleportation, you need big clouds of particles. How big? The bigger the better. The theorists had done all the math in the context of essentially infinitely large clouds. For an experiment, researchers generally agree that 100 particles per cloud would suffice for indisputable wormhole-behavior to emerge. 1023

The mathematics used in quantum physics to prove the case of side winding and gravitational effects is called Hamilton mathematics. Even for 100 densely packed particles the Hamilton would have 3,921,225 terms. Even for a fuzzy wormhole of 20 densely packed particles the Hamilton would have 4,845 terms. Therefore, the critics believed that actually proving the original idea of the experiment is a decade away due to the infancy of the Sycamore chip. But it does seem like they are on the right track.

Multiple Mouth Wormholes

In the section entitled “Multipartite Entanglement” in the “Quantum Entanglement” section, I looked at cases of multiple entangled systems. In this section on wormholes, I looked at the possibility discussed by Susskind and others of entangled wormholes due to two entangled blackholes. But these discussions involved two blackholes connected by one wormhole. I want to make two points at this juncture:

- Exformation through the singularity of the blackhole

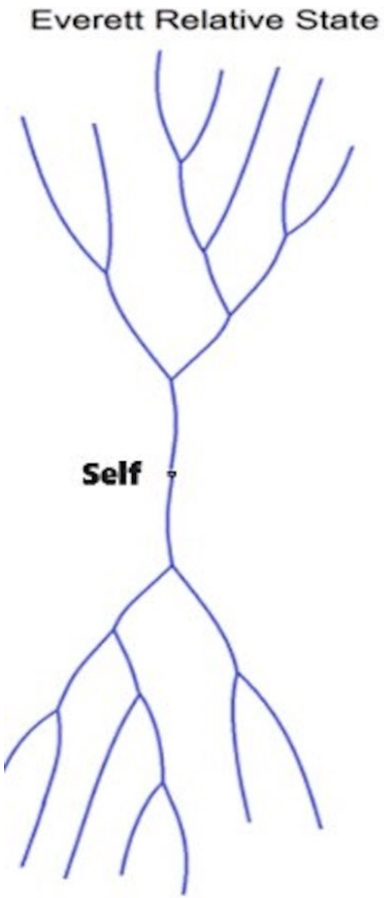
connects both blackholes.
- Entangled quantum bits or qubits are believed to have tiny wormholes between them.

Blackholes with a wormhole in between may be scaled up versions of two entangled particles as well as tiny wormholes. Let's take a detour to pull in how wormholes as highly entangled systems can, just like any entangled system, be entangled with multiple other systems. This implies that wormholes are not just between two blackholes but could be entangled with multiple wormholes simultaneously. The entries into blackholes are called 'mouths'.

A multi-mouth exformationally traversable wormhole is a theoretical construct in physics that describes a wormhole with multiple mouths in four-dimensional spacetime. These wormholes can be traversed between any pair of mouths, and in the three-mouth case, they have fundamental group F2 (the free group on two generators). The construction of these wormholes may begin with a two-mouth traversable wormhole supported by backreaction from quantum fields. Inserting a sufficiently small black hole into its throat may preserve exformational traversability between the original two mouths. However, this new small black hole may be taken to be the mouth of another wormhole connecting the original throat in which it was inserted to a new distant region of spacetime. This makes the new wormhole traversable in a manner similar to the original two-mouth wormhole. This is the case of a tripartite wormhole. It may make spooky exformational connections just like we saw with multipartite entangled systems. From a dual field theory point of view, when anti-de Sitter (AdS) asymptotics (limits which can only be approached more and more infinitesimally but never reached) are added to our construction, multiparty entanglement may play an important role in exformational traversability of the resulting wormholes. [1024]

Additionally, as I tried to illustrate in "The Quantum Wave Function" section, the collapse into classicism is not a Copenhagen

style collapse where all other branches are thrown away but the branch in which we, the observer, is entangled with this being one possible outcome or branch of the wave function. But in Everett's formulation this does not annihilate all the other possible branches. The wave function continues on without catering to our particular 'collapse' into classicism and our 'individual' perception or measurement in physics proper. In "Everett and the Self in the major section, "The Quantum Wave Function", I showed this diagram,



In that section I stated,

> It might look like our lifetime is the length of the line which connects the upper and lower part of the diagram but that would be wrong. That line is simply an exaggeration for clarity. The real case is that our lifetime is the hypothetical dot next to the text, "Self'. We call this the 'now moment' but that is wrong as well. Why? Because that derives from the fall into classicism. This is the quantum wave function branching. In our common vernacular we say that the only thing which remains the same is change. This temporal diagram is what the quantum wave function terms unitarity. The point is what the Copenhagen interpretation called collapse and what Everett's interpretation calls branching. But here is the rub. Whatever you call it, all the other branches are just as what we classically call 'real' as the somewhat misleading diagram makes it look unitarily. Unitarity, going forward or backward in time is an important assumption in the quantum wave function. But as I have pointed out superposition is a-temporal. Superposition is "Everything, Everywhere All at Once." [1026]

I know there are major differences in multipartite entanglement, multipartite wormholes, and all the branches shown above but in my own unenlightened opinion, I see a pattern emerging in all three of these cases. All of these cases have similar branching type patterns in the different contexts of multipartite entangled systems, multipartite wormholes, and Everett's quantum branching. All three contexts involve exformation. All of them share spooky action at a distance coupled with the very odd observer effect which measures, teleports exformation, and exceeds our convenient classical categories of ontology and epistemology in even thinking 'what the wave function' ***is***. [1027] All this brings me back to the tree of life (*etz chaim*).

The Holographic Big Bang

2-D Event Horizon And 3-D Interior of the Hologram [1028]

There seems to be a lot of excitement about the idea that the very large spacetime is emergent from the very small, entangled information, exformation. The mathematics involved in reconciling the very large with the very small is very complex now. However, it could be used to simulate the behavior of the universe, blackholes and the Big Bang, not to mention what may include tiny wormholes of entangled particles and systems including qubits. This would truly be the famed theory of everything. This magnificent idea goes by the name of the 'Holographic Principle'. It is a specific cosmological hypothesis where the 3D universe emerged from a 2D information state. As a theoretical "what if," it is factually consistent with the fringe of modern cosmology. The idea of a hologram is that a two-dimensional film can be projected as a three-dimensional image. Information is encoded in the 2-D image which gets decoded and projected onto a 3-D image. However, instead of pixels of an image, the hologram principle uses 'voxels', massive collections of tiny space-filling volumes.

> That's what makes holograms so surprising. A hologram is a two-dimensional image—an image on a piece of film—that allows you to unambiguously reconstruct full-blown three-dimensional images. You can walk around the reconstructed holographic image and see it from all sides. Your powers of depth perception allow you to determine which object in a hologram is closer or farther away. Indeed, if you move, the

farther object can become the closer object. A hologram is a two-dimensional image, but one that has the full information of a three-dimensional scene. However, if you actually look closely at the two-dimensional film that contains the information, you see absolutely nothing recognizable. The image is thoroughly scrambled.

The information on a hologram, although scrambled, could be located on pixels. Of course nothing is for free. To describe the volume of space one thousand pixels on a side, the hologram would have to be composed of one billion pixels, not one million.

One of the strangest discoveries of modern physics is that the world is a kind of holographic image. But even more surprising, the number of pixels the hologram comprises is proportional only to the area of the region being described, not the volume. It is as though the full three-dimensional content of a region, one billion voxels in volume, can be described on a computer screen containing only a million pixels! Picture yourself in an enormous room bounded by walls, a ceiling, and a floor. Better yet, think of yourself as being in a large spherical space. According to the Holographic Principle, that fly just in front of your nose is really a kind of holographic image of data stored on the two-dimensional boundary of the room. In fact you and everything else in the room are images of data stored on a quantum hologram located on the boundary. The hologram is a two-dimensional array of tiny pixels—not voxels—each as big as the Planck length! Of course the nature of the quantum hologram and the way it codes three-dimensional data is very different from the way ordinary holograms work. But they do have in common that the three-dimensional world is completely scrambled.

What does this have to do with black holes? Let's place a black hole in our large spherical room. Everything—black

hole, space traveler, mother ship—is stored as information on the holographic walls of the space. The two different pictures that black hole complementarity tries to reconcile are simply two different reconstructions of the same hologram by two different reconstruction algorithms!

The Holographic Principle was not widely accepted when ’t Hooft and I put it forward in the early 1990s. My own view was that it was correct but that it would take many decades until we knew enough about quantum mechanics and gravity to confirm it in a precise way. But just three years later, in 1997, all that changed when a young theoretical physicist—Juan Maldacena—electrified the physics world with a paper titled “The Large N Limit of Superconformal Field Theories and Supergravity.” Never mind what the words mean. Maldacena, by cleverly using String Theory and Polchinski’s D-branes, had discovered a completely explicit holographic description of, if not our world, a world similar enough to make a convincing case for the Holographic Principle. Slightly later Ed Witten put his stamp of approval on the Holographic Principle with a follow-up to Maldacena’s paper titled “Anti De Sitter Space and Holography.” Since then the Holographic Principle has matured into one of the cornerstones of modern theoretical physics. It has been used in many ways to illuminate problems that, on the face of them, have nothing to do with black holes.

What does the Holographic Principle have to do with black hole complementarity? The answer is everything. Holograms are incredible scrambles of data that have to be decoded. That can be done by a mathematical algorithm or by shining laser light on the hologram. The laser light implements the mathematical algorithm.

Imagine a scene containing a large black hole and other things that might fall into the black hole as well as the radiation coming out. The entire scene can be described by a

> quantum hologram localized far away on some distant boundary of space. But now there are two possible ways—two algorithms—for decoding the hologram. The first reconstructs the scene as seen from outside the black hole, with the Hawking radiation carrying away all the bits that fell in. But the second reconstruction shows the scene as it would be seen by someone falling into the black hole—one hologram, but two ways to reconstruct its content. [1029]

From the mathematics of Einstein's general relativity to the present we have acquired a better and better idea of how all matter in the universe twists and curves the background of geometric spacetime. Spacetime is not a Cartesian coordinate system due to the geometric curving of spacetime. In Einstein's general relativity, four dimensional spacetime is a vector field called Lorentzian manifolds. Something called tensors can be applied to each point (which is like a vector space that performs certain functions on that space) to map relative frames to each other without the need for inertial frames of reference which are mathematically much more complex for the same amount of information. Different tensors can be employed to look at different characteristics of spacetime. The beauty of all this math is that it makes characteristics of spacetime look smooth and continuous from point to point. If we focus on a small region of general relativity's curved vector field, it will look increasingly like a flat geometric vector field called Minkowski space.

Minkowski space is a special case of the Lorentzian manifold. The Lorentzian manifold is a 1 X N-dimensional space. Minkowski space is a 1 X 3-dimensional space.

> We call a Lorentzian manifold a manifold in which the metric signature is $(1, N-1)$ for a N dimensional space.
>
> Given the fact that the signature of a diagonal matrix is the number of positive, negative and zero numbers on its

> main diagonal, the Minkowski metric has a signature (1,3) in four-dimensional spacetime, and therefore Minkowski spacetime is a special case of Lorentzian manifold.[1030]

Minkowski space is the local space of Einstein's special relativity. Minkowski space is a mathematics of a geometrical, flat space which has a cosmological constant of zero and geometric curvature of zero. It is a four-dimensional (1-time, 3-space) spacetime vector space which considers the effect of the speed of light. The geometric space of Einstein's special theory of relativity is a flat Minkowski space.

> The Minkowski space, which is the simplest solution of the Einstein field equations in vacuum, that is, in the absence of matter, plays a fundamental role in modern physics as it provides the natural mathematical background of the special theory of relativity…
>
> To avoid finite-time singularities, we must require that sufficiently small perturbations of Minkowski space are geodesically complete. This, however, is not enough; one should also insist that the corresponding spacetimes become flat along all possible directions, that is, globally asymptotically flat. This is measured by the decay of the curvature tensor to zero. The precise rate of decay is also of interest. One expects that various null-frame components of the curvature tensor decay at different rates along outgoing null hypersurfaces; this goes under the name of “peeling estimates.” [1031]

This is similar in a certain sense to the static universe space assumed by Newton's mechanics if we ignore the effect of the speed of light. However, Newton knew nothing of the curvature of spacetime. Minkowski’s flat space is different from Newton's aether in terms of the effects of the speed of light.

Lorentzian manifolds do not need to be flat but can work with curved geometries. Combining Lorentzian manifolds with Minkowski space and tensors gives us a mathematical background to spacetime which can handle large, curved distances and small flat distances with the same mathematical structure.

> A Lorentzian manifold is a generalization of Minkowski space in two ways. The total number of spacetime dimensions is not restricted to be 4 (2 or more) and a Lorentzian manifold need not be flat, i.e. it allows for curvature.[1032]

Why is this important? If we take a small enough section of curved geometry, it will look flat. Spacetime is curved and relative to frames of reference. Special relativity shows how light is a speed limit in the universe. General relativity shows how the curvature of spacetime as gravity produces such effects as time dilation and length contraction. Both relativities are highly accurate and for all intents and purposes firmly established.

Think about looking at the surface of a sphere. The closer you look at it the more it will look like a flat plane. The same thing applies to standing on the surface of the earth. If you are standing on it, it looks flat. If you are in the middle of the ocean, you can see the horizon curved because the actual surface of the earth is curved more like a sphere (unless you are a flat-earther). The same idea applies to Lorentzian manifolds with Minkowski space. Minkowski space accommodates both observing curved spacetime on a large scale and focusing on smaller regions, more local regions of spacetime.[1033]

Virtual quanta or virtual particles make up the ‘background’ of the universe which is called zero-point energy or what is more commonly known as the empty vacuum of the universe. This turns out to be an extremely low and uncertain energy which we will very likely never be able to measure directly as it is closer to Planck levels than the levels of atoms and bound particles. Plus, they

conveniently pop in and out of existence as needed by the physics of quanta. The problem is the math of the very small in quantum physics is extremely different from the mathematics of the large on Einstein's relativity field equations.

The historic choice of ‘vacuum space’ borrowed from classical physics is based on the idea of absolute emptiness. However, Newton was wrong assuming that empty space was absolutely empty and a vacuum. Now we know that space is not empty at all. If by 'vacuum’ we mean 'no air’, duhh, no brainer. Funny, the phrase 'empty space' still hangs around physicists at times as a kind of romantic allusion to the past, but they all know this is totally wrong. The absolute emptiness of space has become a misnomer for the frenetic, bubbling, foam of uncertain spacetime energy which is below any directly measurable levels, and it is highly likely we will never be able to measure it. However, we know it exists from the effects I detailed earlier (static electric charge which contributes to generating lightning, etc.) and much more. Vacuum energy is the canvas on which the spacetime of the universe is painted. Mathematically it is important to model vacuum energy as a base upon which other features of the universe can be added.

Let’s suppose that the entire universe could be looked at from the outside. In that case it may look like the event horizon of a huge blackhole. But our perspective from the inside of the universe might actually look more like the interior of a blackhole than we may imagine. This gives us an idea of two seemingly disparate backgrounds, the two-dimensional universe’s boundary we see from the outside which looks like an event horizon boundary and the three-dimensional interior volume (ignoring a time dimension) we live and move and have our being in. Together this makes up ‘our’ universe. Notice that from the outside and from the inside they look very different, but they may remind us of something we have already seen with the observer effect of the wavicle that we call complementarity. Blackholes could be thought of in the same way but as only miniature or even perhaps entire universes. Let's look at

how blackholes are the physical manifestations of both perspectives. We know that nature combines these perspectives in blackholes and now we have ideas about how that happens.[1034]

Blackholes are very important to understand because they uniquely combine two very important and current seemingly disparate areas of physics:

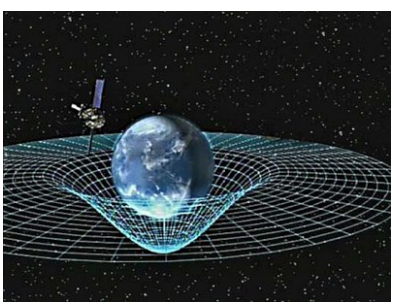
- The very large aspect of extremely deformed curved spacetime which we call gravity.
- The very small of the quantum physics world where entanglement is “the characteristic trait of quantum mechanics’.

If we can find a link between these very different understandings of blackholes, we will learn a tremendous amount about our own universe. Even more, physicists and others have speculated that our universe may be inside an ancient blackhole. From the previous discussion on blackholes we learned that the inside of a blackhole may really be the outside of the blackhole. The indistinguishability of the inside and outside, large and small, etc. is Alice’s rabbit hole. Our commonsense is simply just another classical narrative from wave function branching. We may ‘think’ the ‘output’ of a white hole singularity as spewing out spacetime, creating our universe. We conventionally think in a blackhole all spacetime goes ‘down’ from the event horizon and as exformation also rises ‘up’ in the form of Hawking radiation. Then we may think all that highly chaotic exformation gets crunched down into a ‘singularity’ (can we think quantum wave function). Then we think the singularity is a wormhole. Then we think all that exformation reemerges from the singularity as a white hole. But if Alice and quantum physics are correct the outside and the inside are simply engrained ways that we have accustomed ourselves to think ‘reality’. In this case the outside and the inside may well simply be just yet another complementarity which is dependent on how we

imagine the same phenomenon e.g., as an input or output. But it may just as well simply be how we fall – *vis-à-vis* the observer effect, into classicism from the quantum wave function.

Blackhole research is shedding a lot of light on how our universe emerges from exformation. There has been a lot of research on blackholes from Einstein on. The intriguing reason for studying blackholes is because blackholes are the physical connection of gravity, the very large, and quantum physics, the very small. Bridging the very large with the very small in physics theory would help us understand how the force of gravity united with the other three forces of electromagnetism, weak forces, and strong forces.

Geometry and Spacetime



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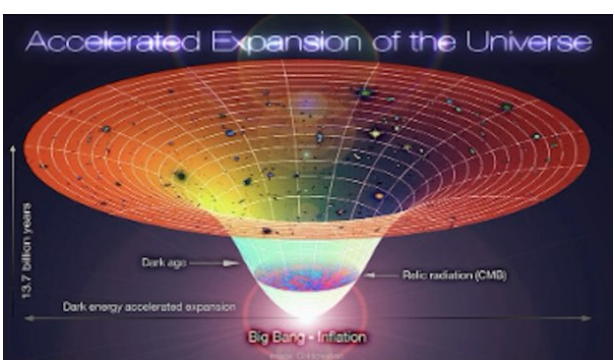


1036

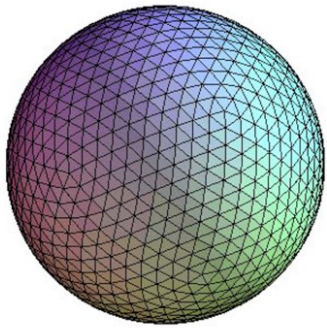
The earth sits in a gravity well (left) and the accelerating universe (right) are images of positive geometric curvature. [1037]

Spacetime is geometric. Spacetime can be curved on large universal scales and also on smaller regional scales. Blackholes, which are factories that combine geometric spacetime to quantum mechanics. The geometry of blackholes has provided a tremendous amount of mathematical information on how geometry works with quanta.

To start this discussion let's think about the geometry of spacetime. Spacetime is curved, which we know is what causes acceleration of inertial mass or ‘gravity’. In certain regions of spacetime, the newly discovered quantum Higgs boson slows down particles from the speed of light to give them different masses. Without mass there would be no universe, only a soup of subatomic particles traveling at the speed of light. Curvature is a geometric concept. The curvature of the universe is determined by the mass-energy content of the universe and the geometry of space-time. The curvature of the universe is determined by the critical density of the universe, which is the density required for the universe to be flat. If the actual density of the universe is less than the critical density, the universe has a negative curvature and is hyperbolic. If the actual density of the universe is equal to the critical density, the universe is flat. If the actual density of the universe is greater than the critical density, the universe is believed by physicists to have a positive curvature and is spherical. A surface has positive curvature at a point if all the curves passing through that point bend in the same direction. The curvature is negative at that point if there are curves that pass through the point bending in opposite directions like a saddle.

There are three different types of curvature shown below,

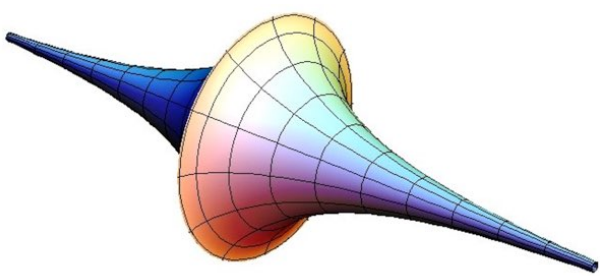
Positive Curvature



1038

A sphere is an example of a shape with constant positive curvature – that means the curvature at every point is the same. 1039

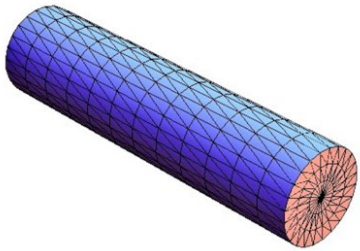
Negative Curvature



1040

Zero Curvature

The pseudosphere is a shape which is in some respects the opposite of a sphere (hence the name pseudo-sphere). This shape has a constant negative curvature. It is formed by a surface of revolution of a called a tractrix. 1041



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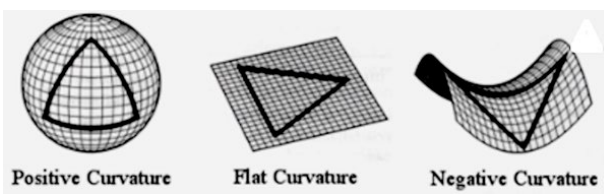
It might be surprising at first to find that the cylinder is a shape which is classified as having zero curvature. But one of the lines drawn on it will always be flat – hence we have zero curvature. We can think of the cylinder as analogous to the flat plane – because we could unravel the cylinder without bending or stretching it, and achieve a flat plane.

1043



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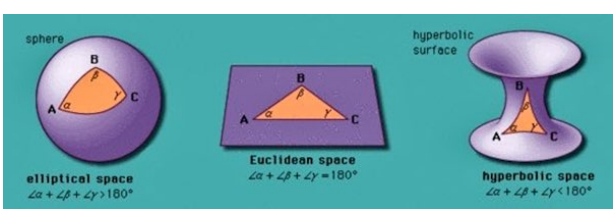

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Triangles on shapes with positive curvature have angles which add to more than 180 degrees. Triangles on shapes with negative curvature have angles which add to less than 180 degrees. Triangles on shapes with no curvature are our familiar 180 degree types. Pythagoras' theorem no longer holds, and circles no longer have pi as a ratio of their circumference and diameter outside of non-curved space. [1046]

For an intuitive understanding, imagine a flat sheet of paper (or just grab one in your hand). It has zero Gaussian curvature. If you take that sheet and bend it or roll it up into a tube or twist it into a cone, its Gaussian curvature stays zero. Indeed, since paper isn't particularly elastic, pretty much anything you can do to the sheet that still lets you flatten it back into a flat sheet without wrinkles or tears will preserve its Gaussian curvature. Now take that sheet and wrap it over a sphere. You'll notice that you have to wrinkle the sheet, especially around the edges, to make it conform to the sphere's surface. That's because a sphere has positive Gaussian curvature, and so the circumference of a circle drawn on a sphere is less than π times its diameter. The wrinkles on the paper are where you have to fold it to get rid of that excess circumference. Similarly, if you tried to wrap the sheet of paper over a saddle-shaped surface, you'd find that you would have to tear it (or crumple it in the middle) to make it lie on the surface. That's because, on a surface with negative Gaussian curvature, the circumference of a circle is longer than π times its diameter, and so, to make a flat sheet lie along such a surface, you either have to tear it to increase the circumference or wrinkle it in the middle to reduce the radius. [1047]

As already mentioned, the cosmological constant is a term that was temporarily added to the field equations of general relativity by Albert Einstein to counterbalance the effect of gravity and achieve a static universe. It is usually denoted by the Greek capital letter lambda: Λ. The cosmological constant is closely associated with the concept of dark energy, which is believed to be responsible for the accelerating expansion of the universe. The geometry of the

universe is determined by the density parameter Ω. If Ω is less than 1, the universe has negatively curved or hyperbolic geometry. If Ω is equal to 1, the universe has Euclidean or flat geometry. If Ω is greater than 1, the universe has positively curved or spherical geometry. The cosmological constant is related to the geometry of the universe in the sense that it affects the curvature of spacetime. The cosmological constant can be interpreted as the energy density of the vacuum, which means it can be put on the left-hand side of Einstein's equations with the geometry (as Einstein did), or on the right-hand side with the stress-energy, both forms being mathematically equivalent. The cosmological constant is a term that affects the curvature of spacetime and is closely associated with the concept of dark energy, which is believed to be responsible for the accelerating expansion of the universe. The geometry of the universe is determined by the density parameter Ω, which can be affected by the cosmological constant. 1048

What is important to note here is that the cosmological constant is related to all three of these geometries. The cosmological constant has to do with the energy density of zero-point energy, the vacuum energy density of space. A positive energy density of zero-point energy implies a negative pressure. A negative pressure could drive an accelerated expansion of the universe. It is unclear what a negative energy density of zero-point energy would do to the universe. However, some physicists, such as Lawrence Krauss, Stephen Hawking, or Alexander Vilenkin, have proposed that the universe could have emerged from a large-scale quantum fluctuation of vacuum energy, resulting in its positive mass-energy being exactly balanced by its negative gravitational potential energy. 1049 A geometrically flat universe can be described by de Sitter space. A de Sitter universe is a cosmological solution to the Einstein field equations of general relativity, named after Willem de Sitter. It models the universe as spatially flat and neglects ordinary matter, so the dynamics of the universe are dominated by the cosmological constant, thought to correspond to dark energy in our

universe and even the hyper-inflation field in the early universe.

The spatial geometry of the Einstein-de Sitter universe is Euclidean (infinite total volume), but space-time is not globally flat (i.e., not exactly the space-time of special relativity). In 1932, Einstein and De Sitter proposed an even simpler cosmic model by assuming a vanishing spatial curvature as well as a vanishing cosmological constant. In modern parlance, the Einstein-de Sitter universe can be described as a cosmological model for a flat matter-only Friedmann-Lemaître-Robertson-Walker metric (FLRW) universe. Additionally, a flat curvature is a term used to describe a Riemannian manifold in which the Riemann curvature tensor is everywhere zero. In other words, a flat manifold is one that "locally looks like" Euclidean space in terms of distances and angles, e.g. the interior angles of a triangle add up to 180°. A flat manifold can be characterized as a manifold with zero curvature everywhere. 1050

In summary,

- The cosmological constant is closely associated with the concept of dark energy. According to quantum field theory, which underlies modern particle physics, empty space is defined by the vacuum state, which is composed of a collection of quantum fields. All these quantum fields exhibit fluctuations in their ground state (lowest energy density) arising from the zero-point energy present everywhere in space. These zero-point fluctuations should act as a contribution to the cosmological constant, but when calculations are performed, these fluctuations give rise to an enormous vacuum energy. The discrepancy between theorized vacuum energy from quantum field theory and observed vacuum energy from cosmology is a source of major contention, with the values predicted exceeding observation by some 120 orders of magnitude, a discrepancy that has been called the worst theoretical prediction in the history of physics! This issue is called

the cosmological constant problem, and it is one of the greatest mysteries in science with many physicists believing that the vacuum holds the key to a full understanding of nature. 1051

- On smaller chunkier scales, spacetime in our universe has all three curved geometries in regions. However, if you look at the universe from a long distance, you will see that one geometric curvature prevails. At a long distance, our universe looks smooth like it has a positive geometric curvature which is very close to a flat geometric curvature. This means our universe is expanding. A positive geometric curvature of the universe would cause it to expand. A flat geometry or zero cosmological constant would cause a static universe. Einstein's general relativity field equations work equally well for all three geometries.
- The cosmological constant is a 'constant scalar curvature'. This simply means it is a single number. Think of looking at overall curvature from a distance. In our universe, the amount of curvature is a single number that is positive but close to zero or flat. Our universe may have a small positive number. That number is still not settled in physics. This is quite embarrassing to physicists. Another way to look at our cosmological constant is as a single number that is, on average, the same everywhere in spacetime caused by the average of all the energy in the universe. Remember that mass is related to energy from Einstein's formula, $e = mc^2$. On a smaller scale, we see lumpiness of spacetime geometry caused by mass. Our earth sits in a 'well' of spacetime caused by the mass of the earth bending spacetime downwards. The 'well' has a geometric negative curvature so it is attractive, meaning we can stand on the surface of the earth and not fly off. We call this gravity.

- On a larger universal scale, the universe has a positive geometric shape of cosmological constant meaning our universe could accelerate the expansion of the universe. Repulsive energy that is associated with dark energy is believed to be the driving force behind the accelerating expansion of the universe. Dark energy is a mysterious form of energy that makes up roughly 68% of the energy in the known universe. Dark matter, on the other hand, is a type of matter that is believed to make up roughly 27% of the mass in the universe. It is called “dark” because it does not interact with light or other forms of electromagnetic radiation, making it invisible to telescopes. Dark matter is attractive. Therefore, the repulsive energy associated with dark energy combined with the attractive energy of dark matter is believed to be the driving force behind the accelerating expansion of the universe. Scientists believe that the amount of repulsion displayed by dark energy teamed up with dark matter not only causes our universe to expand, but also to expand faster and faster. 1052

Here is an interesting idea from a Nobel laureate in physics named Steven Weinberg (1933- 2021).

> With the cosmological constant explanation leading the theoretical pack, the problem of its inexplicable weakness comes to the forefront. Realizing this problem with the constant even before the discovery of accelerating expansion, physicist Steven Weinberg of the University of Texas at Austin suggested a new paradigm—one in which the cosmological constant is not uniquely determined from the basic laws of physics but rather is a random variable that assumes different values in different members of a huge ensemble of universes—a multiverse. Some universes may

> have much larger cosmological constants, but in those the accelerating repulsive force is so large that matter cannot coalesce to form galaxies, planets and life. Because we exist, Weinberg reasons, we clearly have to find ourselves in one of those universes that can allow for our existence—one that happened to have a small cosmological constant. 1053

Just speculating, what if the problem with finding an exact value or even a close to exact wave for the cosmological constant is not due to discrepancies of calculations, measurements, theories, etc. but what if it arrives to us from the same source Heisenberg's uncertainty principle comes from? Everett's simultaneous many branchings, many-worlds, which may not be separate worlds, but confluences, overlapping and interwoven worlds combined together with the observer effect resulting in the impossibility of ever finding a cogent scalar value for the cosmological constant! Or perhaps an easier solution would be given in a later section entitled, "Are we Living in a Blackhole?" For now, let's look at the holographic principle's math from a high level which makes it so appealing.

First Look at de Sitter (dS) and Conformal Field Theory (CFT)

An amazing mathematics arising out of string theory is the secret as to how ER = EPR. This mathematics is formally called anti-de Sitter (AdS) and conformal field theory (CFT). It is the mathematics of the holographic principle. Anti-de Sitter is almost the same, with one tiny but BIG difference. A positive cosmological constant ($\Lambda > 0$) leads to an accelerated expansion of the universe, as observed. Conversely, a negative cosmological constant ($\Lambda < 0$) would have the opposite effect, causing geodesics to contract (i.e., decreasing the expansion) under its influence. De-Sitter space is a mathematics of general relativity. Conformal field theory is a mathematics of quantum mechanics. Together in the holographic principle they are referred to as AdS/CFT. 1054

AdS/CFT is a conjectured relationship between two kinds of physical theories: anti-de Sitter spaces (AdS) which are used in theories of quantum gravity, formulated in terms of string theory or M-theory, and conformal field theories (CFT) which are quantum field theories, including theories similar to the Yang–Mills theories that describe elementary particles. The AdS/CFT correspondence provides a non-perturbative formulation of string theory with certain boundary conditions and is the most successful realization of the holographic principle, an idea in quantum gravity originally proposed by Gerard 't Hooft and promoted by Leonard Susskind. It also provides a powerful toolkit for studying strongly coupled quantum field theories. The AdS/CFT correspondence was first proposed by Juan Maldacena in late 1997. 1055

For most of the history of science there was a need to describe the initial blank canvas of the universe, the fabric or foundation upon which the universe was built on as the aether. The aether was blank space or vacuum space without any planets, suns, galaxies, etc. on it. All matter was built on the foundation of the aether. Einstein’s relativity eventually replaced the aether that science never found with his much simpler theory of light. Beer drinkers all over the world were crying in their beer when their pee was not found to be the source of all light.

Any picture always has a background. There are two important and widely used ‘background’ mathematics for general relativity's spacetime and quantum physics field descriptions. If we can get an idea of how both of these background mathematics can be reconciled, we may be able to get a clearer idea of how blackholes and our universe get the job done. We will discuss this mathematics in a non-technical way in the sections which follow.

In much of later modern cosmology, if we want to mathematically understand how some phenomenon works, we cannot just look at the phenomenon itself. We need to have a mathematical model or environment upon which the phenomenon is operating. Since the later modern universe cannot assume

absolute time and space and since we know that the environment plays a role in how a particular phenomenon works and vice versa, we must have a mathematical environment which adequately describes the setting in which a phenomenon is observed. For current cosmology, the background settings are two:

- one for the very large of spacetime
- one for the very small of quantum physics

The Very Large

De Sitter space and anti-de Sitter space describes the very large, spacetime. There are two major mathematical solutions already used extensively which do this to describe gravitational processes and quantum processes. They are called anti de Sitter (AdS) space and Conformal Field Theory (CFT) which together represent the holographic principle which tells us about the very large and the very small which we see in phenomena like Big Bangs, Black Holes, and our universe. Therefore, the common nomenclature for the holographic principle is AdS/CFT. De Sitter space is widely used in Einstein's general relativity which describes the geometric curvature of spacetime at a distance as positive curvature. Anti-de Sitter space describes the geometric curvature of spacetime at a distance as negative curvature. Think about the picture of the earth in the well above. If you were looking up from the bottom of the well, you would see a positive curvature. All the interior angles of a triangle looking up from the bottom of the well get larger and larger than one hundred and eighty degrees. However, if you were on the outside of the well looking into the well, all the interior angles of a triangle would get smaller and smaller than one hundred and eighty degrees. If there wasn't a well just a flat piece of paper all the interior angles of a triangle would equal one hundred and eighty degrees. The point is that curvature is relative to where you look at it unless there is not curvature because it is flat. A flat universe is a static universe, not expanding or contracting. Otherwise, a curved

universe depends on where you are looking from as to whether you see a positive curvature or a negative curvature.

The Very Small

Conformal field theories which include gauge theories describe the very small, quantum mechanics.

Both mathematics have been amazingly and successfully combined in what is called the Holographic Principle. So, what is the difference between de Sitter space and anti-de Sitter space?

de Sitter Space

In mathematical physics, de Sitter space is a maximally symmetric Lorentzian manifold with constant positive scalar curvature. Say what? A maximally symmetric Lorentzian manifold with constant positive scalar curvature is a spacetime in which no point in space and time can be distinguished in any way from another, and (being Lorentzian) the only way in which a direction (or tangent to a path at a spacetime point) can be distinguished is whether it is space-like, light-like, or time-like. In mathematical physics, de Sitter space is an example of such a manifold. It is a maximally symmetric Lorentzian manifold with constant positive scalar curvature, a positive cosmological constant. Remember that a positive cosmological constant is a term in Einstein's field equations of general relativity that represents the energy density of space or vacuum energy. Negative pressure is a property of dark energy, which is a hypothetical form of energy that could contribute to the accelerating expansion of the universe. The vacuum energy in empty space, according to theory, should have a negative pressure and could be the source of the repulsive gravity driving the accelerated expansion of the universe. The cosmological constant, which is a mathematical constant that represents the energy density of the vacuum of space, is one possible explanation for dark energy. A positive vacuum energy density resulting from a cosmological constant implies a negative pressure, and vice versa. If the energy

density is positive, the associated negative pressure may drive an accelerated expansion of the universe, as observed. The de Sitter accelerating universe is believed to have started 10^{-33} seconds after the Big Bang and continues to this day. [1056]

Anti-de Sitter Space

In mathematical physics, anti-de Sitter space just like de Sitter space also is a maximally symmetric Lorentzian manifold except with a constant negative scalar curvature. The anti-de Sitter space in AdS/CFT correspondence does not imply that the universe is contracting. Rather, it is a mathematical tool that allows physicists to study certain aspects of quantum gravity and gauge theories. The correspondence is based on the idea that the physics of a gravitational theory in a certain space can be described by a non-gravitational theory on the boundary of that space. A simpler way to think of this is we know there is general relativity described by de Sitter space which informs us about spacetime curvature or gravity – the really big. We also believe that if we could look from the outside of the universe, we would see the boundary of the universe which may be like the event horizon of a blackhole. As we will see shortly the event horizon may look like highly encoded exformation described by conformal field theory. But conformal field theory typically uses a positive cosmological constant which does not describe gravity. Therefore, in order to describe gravity, an attractive force, the holographic principle uses anti-de Sitter space which uses a negative cosmological constant bringing in the attractive force of gravity or negatively curved space. This allows the conformal field theory two-dimensional boundary of the blackhole (or universe) – the very small into the three-dimensional volume of anti-de Sitter space as a description of what is inside the blackhole (or universe) and is inclusive of gravity – the very large effect of curved spacetime.

"To better understand the events following the Big Bang, we need a consistent theory of quantum gravity, and the de Sitter universe provides a solution to Einstein's general relativity equation with a positive cosmological constant," says author Tadashi Takayanagi.

This model, which excludes gravity, describes a two-dimensional framework approximating the expansion of our three-dimensional universe, enabling the authors to identify the first example of two-dimensional conformal field theory or CFT that typically utilizes a positive integer for the cosmological constant.

"A special feature of our proposed model is to use a negative cosmological constant to account for gravity on anti-de Sitter space," adds Takayanagi, "thus highlighting the importance of the holographic principle for de Sitter gravity." 1057

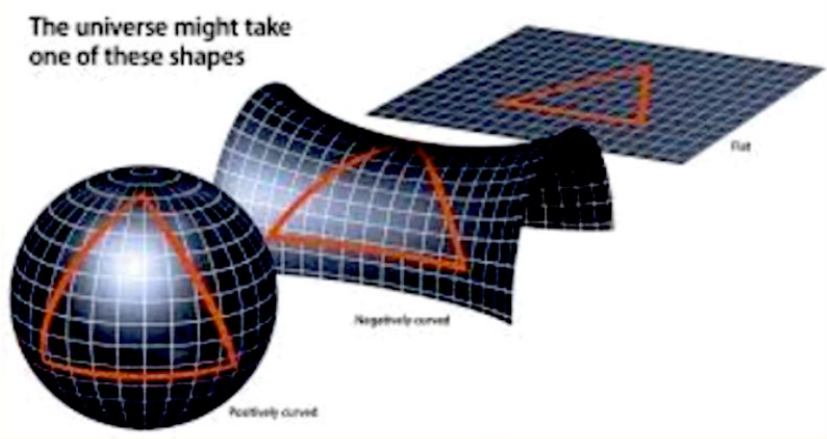
If the geometric curvature of the universe is positive, it does not necessarily mean that space is expanding. The curvature of the universe refers to its local and global geometry, which is defined primarily by its curvature and topology, respectively. The curvature of the universe can be positive, negative, or zero, depending on the sum of its energy density and pressure. A positively curved universe has a closed geometry, resembling a sphere, and its drawn triangle's angles add up to more than 180°. If the universe is indeed positively curved, then it is finite, just like the surface of a sphere is. However, the expansion of the universe is also determined by the Hubble constant, which is a measure of the rate at which the universe is expanding. The Hubble constant is not directly related to the curvature of the universe. Therefore, the curvature of the universe and the expansion of space are two distinct concepts. 1058

If the geometric curvature is hyperbolic or negative, then the space is said to have a saddle shape. In general relativity, the curvature of space is dependent upon the density of the Universe,

and for a density parameter Ω less than unity, the Universe will not have enough mass to collapse and will be in a state of perpetual expansion. In this case, the curvature is negative or hyperbolic. However, it is not accurate to say that space is contracting if the curvature is hyperbolic or negative without taking into account the density of the universe. 1059

Geometry in de Sitter Space

The potential background of zero-point energy or vacuum energy called de Sitter (dS) space is based on positive geometric curvature as shown below. The potential background of zero-point energy or vacuum energy called anti-de Sitter (AdS) space is based on negative geometric curvature as shown below. If there was no net effect of positive or negative zero-point energy or vacuum energy it would be a Riemannian manifold in which the Riemann curvature tensor of zero or Euclidean geometry going all the way back to Euclid (305-282 BC) and even up to Einstein's first take on relativity – static, absolute universe – the dream of classicism!



Note the triangles in the diagrams above. If the sum of the three angles sums up to 180 degrees, we have a flat space. If the sum of the three angles is less than 180 degrees, we have a negative curved space. If the sum of the three angles is greater than 180 degrees, we have a positive curved space.

What do homogeneous and isotropic mean?

> Cosmologists and astronomers almost always assume that the universe is homogeneous and isotropic; no matter where you are in the universe and which direction you are facing, you see the same thing. I don't mean the nearby details but the overall, large-scale features of the universe. Cosmologists call this assumption the cosmological principle. Of course calling it a principle does not make it right. Originally it was just a guess, but gradually better and better observations of several kinds have convinced astronomers and cosmologists that the universe is indeed homogeneous and isotropic over scales ranging from a few hundred million light-years to at least a few tens of billions of light-years. Beyond that we don't know for sure because there is a limit to our observations. It doesn't matter how big our telescope, objects farther than fourteen billion light-years are impossible to observe. The reason is the simple fact that the universe is only about fourteen billion years old. In that time light could not have traveled more than fourteen billion light-years; light from more distant places just hasn't reached us yet. In fact it's a pretty safe bet that the universe is homogeneous and isotropic out to distance scales much larger than the observable part of the universe. But like Farmer Brown's field, the universe may become a crazy quilt at a large enough distance: a patchwork of pocket universes. [1061]

What is curved de Sitter space?

In 4D (3 space and 1 time, often called 3 + 1 space), our universe is curved. Forgetting time, in three dimensions this describes the geometry of space. Now, think of the surface of a universe sized sphere. If you were standing on the surface, it would flat to you but stepping far way you would see the curvature of the sphere. De Sitter space can be flat like Euclidean geometry. However, on a large scale, de Sitter space, like the three geometric dimensions of the universe can be curved. The flat space looks a lot like the quantum mechanics universe which is not affected by the geometric curvature of space or gravity. However, on a larger scale the curved geometry mathematically comes into play as gravity.[1062]

Visualize this, in higher dimensions we can insert lower dimensional shapes into it. We can take a 3D sphere and insert a 2D plane into it without losing any information about either geometry. It can also work the other way. We could insert a 3D sphere into a 2D plane, and it would look like a circle. In that case we could lose some information about what the object looks like in 3D, but that information could be encoded in tiny quanta of the circle which might allow us to reconstruct the original shape of the sphere. This can happen with any number of different dimensions.

> In essence, whether a space is curved or not, we can generally pick out a "slice" of it in one lower dimension that is either curved or flat. It all depends on how we want to define our slice. (The formal name for slicing in this context is "foliation". We foliate a higher D space to get a lower D space. For any given space, there are a slew [generally infinite] number of ways we can foliate to get lower dimension spaces of our choosing.)[1063]

De Sitter is a geometric space which works like this for any number of dimensions.

Why did we go through all this? We know that the curvature of spacetime is responsible for the effect we call gravity. Therefore,

when the curvature of three-dimensional space, de Sitter space, is positive we have a positive cosmological constant. If the curvature is negative, we have a negative cosmological constant. A positive cosmological constant is good because it is repulsive and keeps the attractive force of gravity from collapsing the universe. A negative cosmological constant is bad because it is attractive and would couple with the other attractive force of mass to make the universe go quickly into a big crunch.

What is anti-de Sitter space? A space with a negative curvature. Anti-de Sitter simply has a negative cosmological constant, so it has an attractive background, vacuum energy space. Typically, this is 3D space, a subset of 4D spacetime) which supports work in the curvature of spacetime we call gravity. Combining this mathematics with Conformal Field Theory (CFT), the 2D background which supports quantum vacuum energy, supports the popular mathematics used to analyze blackholes and our universe as a hologram. Below are summaries of important facts,

1. De Sitter (dS) space is the mathematical tool used in general relativity to describe the accelerating expansion of the universe.
2. De Sitter (dS) space describes a positively curved universe.
3. Anti-de Sitter (AdS) space describes a negatively curved universe.
4. A Riemannian manifold in which the Riemann curvature tensor is everywhere zero describes a flat static universe.
5. Both de Sitter (dS) space and anti-de Sitter (AdS) space can be n-dimensional or support dimensions other than three dimensions.
6. Both de Sitter (dS) space and anti-de Sitter (AdS) space is maximally symmetric which means space is both homogeneous, consistently put together on a large scale, and isotropic, similar in all directions.

7. De Sitter (dS) space supports and is used frequently in Einstein's general relativity.
8. Both de Sitter (dS) space and anti-de Sitter (AdS) space describe the vacuum background of space.
9. De Sitter (dS) space is the solution of Einstein's field equations.
10. De Sitter (dS) space has a positive cosmological constant (corresponding to a positive vacuum energy density and negative pressure).
11. Anti-de Sitter (dS) space has a negative cosmological constant (corresponding to a negative vacuum energy density and positive pressure). 1064

Conformal Field Theories

In the context of this section, I am looking at conformal field theory as a complementary part of anti de Sitter space. The holographic principle has two sides of the same 'thing' meaning a blackhole. The event horizon is on the spacetime side of the blackhole. In the hologram analogy, the event horizon is the two-dimensional, highly encoded information about the inside of the blackhole. Notice that I use outside and inside but that is really for visualization purposes. Just as the wavicle depends on how you are observing it to determine what you will see; this is also true of the blackhole. The event horizon is highly entangled, encoded exformation of the 'inside' of the blackhole. This is what we see from the spacetime perspective, looking from the 'outside'. The 'inside' is anti-de Sitter, three-dimensional space. It is the unencoded volume information which the event horizon encodes. We cannot see the unencoded volume information from the 'outside' of the blackhole. However, unencoded does not mean unentangled. Hawking radiation is the spacetime side of what is encoded in the blackhole. The complementarity side of the event horizon in the holographic principle is the mathematics of conformal field theory. One other

note as already discussed in the section entitled, “The Physics Time Problem”, remember that time does not exist for quanta except as the observer effect. With that said let’s take a closer look at conformal field theory.

Ok, this is a bit difficult so bear with me. First, I will try to give an overview of what this is about. When a quantum system is stable everything is cool, this implies a certain symmetry is maintained. Conformal field theory is a kind of standard which tells us characteristics of a stable, symmetric quantum system. But symmetry can be broken. Physicists want to understand what happens when symmetry is broken, and stable symmetric systems change chaotically or unpredictably. That is, when the system is no longer conformal. Every point in a stable system is a stress point meaning at each point there is an indication of how much stress that point can take before all hell breaks loose. The mathematical name for that point is called a stress tensor. If the stress tensor is zero, everything is cool, no worries. But when the stress tensor is not zero watch out symmetry is in danger.

> A classically conformal field theory has an action invariant under conformal transformations and the conformal invariance implies a vanishing trace of the stress tensor. The well-known trace anomaly represents a quantum phenomenon that breaks the conformal symmetry and the trace of the “expectation value” of the stress tensor becomes non-zero. In general, a conformal field theory can be characterized by the trace anomaly coefficients or central charges of the stress tensor. [1065]

Actually, learning how things break is a really good way to understand how to keep them from breaking. This is really important when we get to areas like quantum computing.

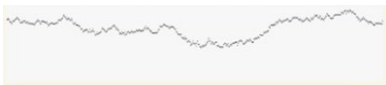
With the easy part out of the way let’s have some more ‘fun’ as a physicist would call it – NOT! A conformal field can be many types

of quantum fields. By ‘conformal’ what is meant is that fields that are conformal conform to a certain standard. Specifically, conformal field theory is a type of quantum field theory that is invariant or unchanged under conformal transformations. In two dimensions as in the holographic principle, there is an infinite-dimensional algebra of local conformal transformations, and conformal field theories can sometimes be exactly solved or classified. Conformal transformations are transformations that preserve angles but not necessarily distances. Conformal field theories describe systems at the critical point called a phase transition, where the correlation length diverges. [1066]

When we say that a phase transition occurs where the correlation length diverges, we mean that the system undergoes a change in its physical properties, such as its temperature or pressure, and the correlation length of the system diverges at the critical point. The correlation length is a measure of how strongly two points in a system are correlated with each other. At the critical point, the correlation length of the system becomes infinite, which means that the system becomes scale invariant. [1067]

When we say that a system becomes scale invariant, we mean that the system looks the same at every scale. In other words, if we zoom in or out, our view of the system and its features remain unchanged. Scale invariance is a feature of objects or laws that do not change if scales of length, energy, or other variables, are multiplied by a common factor, and thus represent a kind of similarity regardless of scale. In other words, these systems have no inherent length scale. The technical term for this transformation is dilatation. Dilatations can form part of a larger conformal symmetry. In a scale-invariant theory, the strength of particle interactions does not depend on the energy of the particles involved. In statistical mechanics, scale invariance is a feature of phase transitions. The key observation is that near a phase transition or critical point, fluctuations occur at all length scales, and thus one should look for an explicitly scale-invariant theory to

describe the phenomena. Such theories are scale-invariant statistical field theories and are formally very similar to scale-invariant quantum field theories. The observation that widely different microscopic systems can display the same behavior at a phase transition is actually quite astounding if you think about it. Let me try to frame this in a simpler perspective. A picture speaks a thousand words here,



[1068]

Note: If the animation does not work click on the link in the footnote.

Normally, when we think something changes, we think of the change itself as bigger for major changes and smaller for minor changes. But in quantum mechanics the actual change itself has no scale. In other words, it has nothing to do with any kind of scale by which we can measure any differences. The whole idea that scale of change means nothing in terms of size, magnitude, etc. is an alien idea from the standpoint of classicism. [1069]

Again, a field theory described by a Lagrangian invariant up to a total derivative under a conformal transformation is said to be a conformal field theory. A Lagrangian invariant is a property of a field theory where the Lagrangian density is invariant under a certain transformation. In other words, if the Lagrangian density is transformed in a certain way, the resulting Lagrangian density is the same as the original one. The Lagrangian density is a function that describes the dynamics of a field theory. In physics. More simply, the Lagrangian density is often used to describe the behavior of particles and fields. The Lagrangian density is a function of the fields and their derivatives, and it is used to derive the equations of motion for the fields. A field theory described by a Lagrangian

invariant up to a total derivative under a conformal transformation is said to be a conformal field theory. [1070]

Conformal field theories are not just important to the holographic principle but have important applications to condensed matter physics, statistical mechanics, quantum statistical mechanics, and string theory. Statistical and condensed matter systems are indeed often conformally invariant at their thermodynamic or quantum critical points. The development of conformal field theory has been earlier and deeper in the two-dimensional case especially after a 1983 article by Belavin, Polyakov and Zamolodchikov. [1071]

Scalar fields, fermionic fields, and gauge fields are all types of quantum fields that are used to describe the behavior of subatomic particles and their interactions with each other and with electromagnetic radiation. Scalar fields are fields that have a single value at each point in space-time. Scalar fields describe particles with zero spin, such as the Higgs boson. Fermionic fields are fields that describe particles with half-integer spin, such as electrons and quarks. Gauge fields describe the fundamental forces of nature, such as the electromagnetic force and the strong force. So, how are these fields and the wave function related?

The wave function is a solution to the Schrödinger equation, which is a partial differential equation that describes how the wave function evolves over time. The wave function is a fundamental concept in quantum mechanics that describes the state of a quantum system. The wave function is a complex-valued function that encodes the probability amplitude of finding a particle in a particular state. In quantum field theory, the wave function is replaced by a quantum field, which is a field that satisfies the principles of quantum mechanics. While scalar fields, fermionic fields, and gauge fields are all types of quantum fields, they are not directly related to the quantum wave function. However, both quantum fields and the wave function are used to describe the behavior of subatomic particles and their interactions with each other and with electromagnetic radiation. The relationship between

conformal field theory and the quantum wave function is not straightforward, as conformal field theories are typically used to describe systems in two dimensions, while the wave function is a concept that is more commonly used in three dimensions. However, both have important applications to the holographic principle, condensed matter physics, statistical mechanics, quantum statistical mechanics, and string theory. Statistical and condensed matter systems are indeed often conformally invariant at their thermodynamic or quantum critical points. In any case, the relationship between conformal field theories and the quantum wave function is an active area of research in theoretical physics. As we have seen, the quantum wave function deals with systems that are entangled. This is another area of overlap between field theories and the wave function.

A Deeper Dive - Conformal Field Theories and Entanglement

The relationship between conformal field theory and entanglement is an active area of research in theoretical physics. Entanglement is resolved in conformal field theory with respect to conformal families 'to all orders in the UV cutoff'. In physics, the UV cutoff is the maximal allowed energy or the shortest allowed distance (usually a very short length scale). To leading order, symmetry-resolved entanglement is connected to the quantum dimension of a conformal family, while to all orders it depends on null vectors. This refers to the idea of making a connection between a certain amount of entanglement and specific individual symmetry sectors of a quantum theory. Symmetry sectors in quantum theory refer to the different ways in which a quantum system can be transformed while preserving its symmetry. In other words, symmetry sectors are the different ways in which a quantum system can be transformed without changing its physical properties. For example, consider a quantum system that is symmetric under rotation. The symmetrical sectors of this system would be the different ways in

which the system can be transformed while preserving its rotational symmetry. These symmetry sectors can be represented by different irreducible representations of the rotation group. Symmetry sectors are important in quantum theory because they help us understand the different ways in which a quantum system can behave. By studying the symmetry sectors of a quantum system, we can gain insight into its physical properties and behavior. All other entangled orders e.g. asymmetrical are simply nulled out or ignored by conformal field theory. Symmetry-resolved entanglement has important applications in many-body systems, including free and interacting fermions, spin and parafermion chains, and more. Additionally, entanglement entropy was predicted to have distinct behaviors which would reflect the central charge of the corresponding conformal field theory, and as such it has often been taken to be an indicator of conformal invariance. Entanglement entropy is a measure of the amount of entanglement between two subsystems of a quantum system. The relationship between entanglement entropy and conformal field theory has been studied in depth. Conformal field theory approach has been used to calculate the entanglement entropy of a single interval, and the generalization to different situations such as finite size, systems with boundaries, and the case of several disjoint intervals. Conformal field theory and entanglement entropy are related, and the former has been used to study the latter in various contexts. The relationship between conformal field theory and entanglement is an active area of research in theoretical physics. 1072

Quantum Gravity: The Very Large and the Very Small

I want to make one preparatory remark before I start this section. Dimensions are not mutually exclusive. Two-dimensional objects can fit into a three-dimensional space. Even three-dimensional objects can fit in a two-dimensional space but may lose some information in the process unless the missing information can

somehow be encoded in less dimensions. If so, it could be decoded to create the original three-dimensional object. This applies to any number of dimensions. As an example of this we think of quantum physics as not playing in the four dimensions of spacetime. We think that spacetime is incompatible with the spooky world of quantum physics where quantum entanglement is the characteristic trait of quantum physics. However, in one instance we saw how the notion of locality could lose its common-sense historic notion of absolute time and absolute space and instead, the amount of entanglement in a system can give us the lived sense of proximity which has nothing to do with linear extension. The point here is that geometry is not our intuitive notion of geometry. Information, exformation, makes seemingly disparate physical geometries play together.

When we think about the very large and the very small, we think of them as two very different ideas. Actually, they are not as different as we might think. We have already seen that size is relative to our relativistic frame. If we are observing a relativistic frame accelerating closer or further from the speed of light our relativistic frame makes simultaneity as time (now moments) and space as large or small highly problematic.

What about the very large?

De Sitter space (dS) is a mathematics commonly used as the vacuum solution of Einstein's general relativity field equations. De Sitter (dS) space is widely used in general relativity, where it serves as one of the simplest mathematical models of the universe consistent with the observed accelerating expansion of the universe. De Sitter space mathematically describes maximally symmetric vacuum space. Maximally symmetric means one point looks like any other point. De Sitter space is one of the simplest mathematical models of Einstein's field equations. De Sitter math uses a positive cosmological constant which is a positive geometric curvature

(gaussian) of the universe. Practically, this means empty space has a repulsive force. More specifically, a positive cosmological constant has positive vacuum energy density with negative pressure (repulsive force) counteracting the positive, attractive force of all the mass in the universe. A positive cosmological constant makes the vacuum energy of the universe expand like our own universe meaning it is a little more repulsive than attractive. Vacuum energy pushes out repulsively more than the positive spacetime curvature of the universe (we call gravity) pulls in. Another way to think about positive spacetime curvature is that the sum of all the mass in the universe is attractive but greater vacuum energy is more repulsive, so the universe does not collapse in on itself. This is why the universe is expanding. If there was less vacuum energy than positive spacetime curvature (gravity) in our universe, our universe would move towards collapse. If positive vacuum energy and spacetime curvature were equal, Newton would have been correct - a static universe. De Sitter space is like the air in a balloon which keeps the balloon from collapsing in on itself. There is cosmological evidence that the universe itself is asymptotically de Sitter space, i.e., it will evolve like the de Sitter universe in the far future when dark energy dominates. More specifically, de Sitter space is the maximally symmetric vacuum solution of Einstein's field equations with a positive cosmological constant (positive scalar curvature) symbolized as ‘Λ’ [Lambda] (corresponding to a positive vacuum energy density and negative pressure or a repulsive force).[1073]

Simply put AdS (anti-de Sitter) space has a negative cosmological constant. AdS is used to study the very large in an exciting new field called quantum gravity. A simplified version of AdS has three spatial dimensions and one time dimension. AdS can be used with any number of dimensions. This makes it highly suitable for the mathematics of strings and branes which have higher dimensions than four and will be discussed more later. Anti-de Sitter (AdS) is a mathematics which can behave equally well as dS (de Sitter) math to describe the lowest energy level of empty

space or vacuum energy. It works equally well with Einstein's general relativity field equations. AdS math uses a negative cosmological constant which means a negative cosmological constant or a negative geometric curve (hyperbolic) to the universe. Since AdS or anti-de Sitter mathematics simply has a negative cosmological constant, this practically means empty space has an attractive force. More specifically, a negative cosmological constant has negative vacuum energy density with positive pressure (attractive force). This is anti-universe for us. AdS can be used to solve Einstein's general relativity equations as well where vacuum energy is contracting a universe and negative spacetime curvature of an anti-universe (we call anti-gravity). Depending on the amounts of attractive vacuum energy and negative spacetime curvature (we call anti-gravity) that universe would either expand, collapse, or stay the same (if vacuum energy and negative spacetime curvature were equal). If we lived in that universe, we would barely be able to distinguish it from our own universe. It would be an 'anti-world'. This reminds us of dark energy and dark mass. Could it be that our universe has pockets where the 'anti-world' prevails? String theory or M-Theory exists in an AdS background vacuum energy.

What about the very small?

Einstein's 1935 EPR paper effectively described quantum entanglement although it wasn't called that until Erwin Schrödinger named it that shortly afterward. If we were to live in the 'reality' entanglement lives in, the wavicles of the Standard Model of quantum physics, or the lowest energy levels of vacuum particles popping in and out of existence as 'virtual particles', we would live in Alice's rabbit hole, perpetual Halloween but not for kids; we would live in chaos. Physics has opened Pandora's box and it cannot be closed. Electromagnetism has a lot to do with the history of how the background vacuum energy of our universe came about.

Let’s recall that Einstein's paper in 1905 special relativity described the very small - the conversion of mass to energy and vice versa. Einstein’s path to special relativity took him along the way of James Maxwell’s electromagnetic field equations. As far back as the 4th century BC the Chinese were aware of magnetism. Many other ancient cultures also became aware of the magical properties of electromagnetism.[1074]

The ancient Egyptians and Greeks and later Arabs were aware of the strange property. In 1865 James Clerk Maxwell published a paper which showed equations which describe the relationship of electric and magnetic fields. Soon after Einstein’s 1915 publication on general relativity he started to work trying to show how general relativity was related to special relativity using electromagnetism. Einstein was very impressed with Maxwell's mid-19th century electromagnetic field equations. These equations showed how the electric and magnetic fields were related. Later, Einstein used these equations to try to find a local explanation for entanglement. He failed in this endeavor. The electromagnetic field has more to do with waves than particles. It sets up a playing field which, for example, is like a football field which comes with certain rules and regulations for what happens within its domain. Conformal Field Theory (CFT) sets up a minimum energy field, a background, where the game of particle physics can unfold.

In mathematics, CFT describes the field, the arena or space, of the very small world in which quantum mechanics exists. A simplified version of CFT has two spatial dimensions and one time dimension. CFT does not include gravity and looks more like the Standard Model of quantum mechanics. However, it can easily stack up more spatial dimensions. CFT is a mathematics of quantum field theory. It is a mathematical background which models the lowest energy level of empty space or vacuum energy. This background is the field or arena where quantum physics plays. It describes uncertain energy levels of virtual particles which pop in and out of existence. In various known phenomena virtual particles can have

very large and observable effects like lightning for instance. An important feature of CFT space is that it can have two dimensions (2D) which has some unique advantages discussed a little later.

The mathematics of CFT is a ***quantum field theory***. It describes how quantum physics acts as fields as opposed to particles. Remember the complementarity idea of wavicles (wave/particle duality). This is the same idea. We can look at quantum mechanics as particles or waves. A wave is a field. It is used widely to describe quantum mechanics, condensed matter physics, statistical mechanics, quantum statistical mechanics, and string theory. It has a special feature in two dimensions, there is an infinite-dimensional algebra for local conformal transformations. CFT can sometimes be solved exactly or at least be classified by type. In effect what this means is that in two dimensions CFT can give us highly reliable mathematics for infinite transformations such as how quantum systems transform themselves. In higher dimensions than two transformations are finite and numerical methods dominate as opposed to more general solutions and classifications. Think of it this way, two dimensions help us predict better, more generally. Higher than two dimensions tend to give us numbers about a specific transformation which cannot be applied so well generally. Since quantum physics processes happen at different scales of energy a process called re-normalization mathematically lets us place these processes in the same scale so they can be compared reliably.[1075]

Combining the very large and the very small

Is there a way to combine the very large and the very small? Yes. Let's recall that Einstein's 1935 ER paper described the very large – effectively, two blackholes joined by a wormhole (the Einstein-Rosen Bridge). The wormhole is a phenomenon which combines the very large and the very small so there must be a mathematical way to do it as well.

As mentioned earlier, the geometry of two dimensions can fit in three dimensions and vice versa or even any other higher-level combinations of geometric dimensions. We can even have tiny compacted higher dimensional geometries living in two-dimensional space which could account for certain odd behaviors in two-dimensional space. This is called string theory or M-Theory. Any lost information in the process of transforming these dimensions can be fully encoded or partially encoded to move back and forth through the disparate dimensions. Quantum physics' geometry can live in a two-dimensional world which knows nothing of spacetime. Spacetime's four-dimensional geometry knows nothing about quantum physics geometry. As we have said, *the characteristic trait of quantum mechanics* entanglement. Therefore, quantum mechanics knows nothing about time. With this in mind, if we lose time from spacetime, can we find a way to combine the world of the very large where gravity lives and plays with the world of quantum mechanics where gravity is non-existent?

Physicists made an amazing discovery, there is a correspondence between the gravity free world and the gravity filled world,

> On the one hand, we have a theory of quantum gravity, say, in 3 + 1 dimensions—3 space dimensions and 1 time dimension. On the other hand, we have a so-called "conformal field theory" (CFT) in 2 + 1 dimensions. This CFT does not include gravity; it is a theory that has the basic trappings of the standard model of particle physics but additionally possesses exaggerated symmetries. The AdS/CFT correspondence means that a dimension of space emerges as we toggle between the gravity-free CFT world and the gravity-filled AdS world.[1076]

In other words, there is a striking mathematical equivalence between AdS and CFT (specifically, described as WZW).

> Another strategy is to generalize the so-called AdS/CFT correspondence, which arguably furnishes our best understanding of quantum gravity to date. AdS stands for anti-de Sitter, which is shorthand for a spacetime with constant, negative curvature. Such a spacetime is a solution to Einstein's equations with a negative cosmological constant. The correspondence stipulates that string theory in an AdS spacetime is (miraculously) equivalent to a theory without gravity in one less spatial dimension.
>
> Appreciating how striking this statement is requires some unpacking. On the one hand, we have a theory of quantum gravity, say, in 3 + 1 dimensions—3 space dimensions and 1 time dimension. On the other hand, we have a so-called "conformal field theory" (CFT) in 2 + 1 dimensions. This CFT does not include gravity; it is a theory that has the basic trappings of the standard model of particle physics but additionally possesses exaggerated symmetries. The AdS/CFT correspondence means that a dimension of space emerges as we toggle between the gravity-free CFT world and the gravity-filled AdS world.[1077]

If spacetime emerges from a 2-D boundary condition which can be linked to the 3-D conditions for gravity, this would be quite an extraordinary finding! The blackhole as a hologram is a beautiful picture of how quantum mechanics and gravity work together. An exciting field in quantum physics is called quantum gravity.

Blackholes are the perfect environment for understanding the link between gravity and quantum physics. A black hole has massive gravity, but it also has quantum physics in its singularity.

> For decades, blackholes have played the headlining role in the thought experiments that physicists use to probe nature's extremes. These invisible spheres form when matter becomes so concentrated that everything within a certain distance,

> even light, gets trapped by its gravity. Albert Einstein equated the force of gravity with curves in the spacetime continuum, but the curvature grows so extreme near a blackhole's center that Einstein's equations break. Thus, generations of physicists have looked to blackholes for clues about the true, quantum origin of gravity, which must fully reveal itself in their hearts and match Einstein's approximate picture everywhere else.[1078]

Are we living inside a blackhole? The mathematics of Conformal Field Theory (CFT) and anti-de Sitter (AdS) spaces work together in a surprising way as a kind of hologram. A hologram projects an encoded two-dimensional (2-D) film which uses lasers to project a three-dimensional (3-D) image. As it turns out this is a perfect analogy for a blackhole. A blackhole has a 2-D event horizon, a surface, which gets decoded as the interior of the blackhole. The 2-D event horizon fits the mathematical description of CFT and the 3D interior of the blackhole fits the mathematical description of AdS. CFT is a description of quantum field theory. AdS is a description of geometric curvature which fits gravity.

Additionally, let's recall pocket universes in a universe. Perhaps we are a pocket universe. Pocket universes can be thought of as bubbles as well. Pocket universes are meta-stable meaning that, like a bubble, they have a membrane, or brane, which can become unstable quickly (whatever that means in the pocket universe's own rules of physics) and burst. Think of this as a potential background of vacuum energy, which sets the stage for a much larger energy landscape that can suddenly and kinetically bursts forming a new stage with a very different landscape, a completely different potential background of vacuum energy setting the stage for a new universe, a completely different script for the laws of physics. Blackholes begin as a metastable event when a large sun collapses in, upon itself.

As we will see, there are many reasons why our universe could

be the inside of a blackhole whose singularity became a white hole.

> The emergence of a dimension of space is often called "holography," by analogy with how a 3D image emerges from a 2D hologram. Many physicists have been drawn to studying the AdS/CFT correspondence because it provides a rich model of emergent spacetime. To interrogate the gravity-filled world of AdS, one can calculate specific quantities in the gravity-free world of CFT. Conversely, one can learn properties of CFT via gravity calculations in AdS.[1079]

Here is an important thing to note: In the Conformal Field Theory (CFT) side of the duality, gravity is mathematically absent. This reflects the Standard Model's approach, where quantum fields are calculated on a fixed, flat background without gravitational curvature (2D). In a flat geometry everything is static. The cosmological constant in a flat vacuum universe is zero. This is classical physics and Newton's static and absolute time and space. Newton turned out to be wrong about a flat, static universe. Quantum physics is not affected by gravity. This means the quantum world acts like a flat universe, a zero cosmological constant. A flat universe is two dimensional and has no attractive or repulsive vacuum energy - it is static. Ignoring time, the positive curvature vacuum universe is three-dimensional like a sphere which corresponds to de Sitter (dS) space. The negative curvature vacuum universe is also three-dimensional like a well which corresponds to anti-de Sitter (AdS) space.

The Hologram - Making flat images look like they are three dimensional

A hologram is the perfect visual example of how to map a two-dimensional image to a three-dimensional image. Nowadays, movie theaters are great examples of how movie projectors can make three

dimensional movies. Holograms combine two dimensions to make them look like three dimensions. Spacetime is very large where what we call gravity plays. Without time, it is three dimensional. The world of quantum physics is very small. It is two dimensional. Remember, that the characteristic trait of quantum physics is entanglement. Entanglement knows nothing about spacetime. It simply goes from one state to another state somehow in the act of spooky observation. So, if the established mathematics of conformal field theory (CFT) and anti de Sitter (AdS) can play together, it will go a long way to understanding how the very large and the very small work together to make a universe.

Remember, de Sitter (dS) space has a positive cosmological constant for spacetime. The cosmological constant is used in relativity as a repulsive force or pressure. It has a positive cosmological constant. It counters the attractive force of gravity. However, because our universe has a positive geometry of spacetime, the repulsive force is a little greater than the attractive force meaning our universe is expanding.

Anti-de Sitter space has a negative cosmological constant. If quantum gravity is formulated in terms of de Sitter space it would pose fundamental problems to quantum physics as time would be emergent instead of three spatial dimensions being emergent on anti-de Sitter space.

> It would be compelling to generalize the AdS/CFT correspondence to the setting of a positive cosmological constant, namely to so-called de Sitter (dS) spacetimes. Over the past 20 years, there have been a multitude of proposals attempting such a generalization. A feature common to several of the proposals is that time is emergent, instead of space being emergent as per the AdS/CFT correspondence. Emergent time is more difficult to fathom, as it entails the emergence of quantum mechanics itself. Indeed, the basic mathematical structures of quantum mechanics have time

> ingrained within them. Accordingly, a dS/CFT correspondence—if it were fully realized—would equate quantum gravity in de Sitter spacetime to a non-quantum-mechanical conformal field theory without time.[1080]

This can be visualized like a hologram. A hologram has a two-dimensional surface but can be projected to look like a three-dimensional object. This seems to be the link between the ER paper and the EPR paper. It is popularly written as ER = EPR. AdS is the mathematics of ER and CFT is the mathematics of EPR. This brings up the question, "Does spacetime emerge from quantum physics?" If so, could we see a small effect of gravity in highly dense, entangled quantum computing bits which may have extremely small wormholes?

> Indeed, the new experiment confirms that quantum effects, of the type that we can control in a quantum computer, can give rise to a phenomenon that we expect to see in relativity — a wormhole. The evolving system of qubits in the Sycamore chip "has this really cool alternative description," said John Preskill, a theoretical physicist at Caltech who was not involved in the experiment. "You can think of the system in a very different language as being gravitational."
>
> To be clear, unlike an ordinary hologram, the wormhole isn't something we can see. While it can be considered "a filament of real spacetime," according to co-author Daniel Jafferis of Harvard University, lead developer of the wormhole teleportation protocol, it's not part of the same reality that we and the Sycamore computer inhabit. The holographic principle says that the two realities — the one with the wormhole and the one with the qubits — are alternate versions of the same physics, but how to conceptualize this kind of duality remains mysterious.[1081]

If gravity as a phenomenon of the three-dimensional world of spacetime could be linked to the two-dimensional surface of quantum information this would link the very large with the very small confirming Einstein's fear of 'spooky-action-at-a-distance'.

> The experiment can be seen as evidence for the holographic principle, a sweeping hypothesis about how the two pillars of fundamental physics, quantum mechanics and general relativity, fit together. Physicists have strived since the 1930s to reconcile these disjointed theories — one, a rulebook for atoms and subatomic particles, the other, Einstein's description of how matter and energy warp the spacetime fabric, generating gravity. The holographic principle, ascendant since the 1990s, posits a mathematical equivalence or "duality" between the two frameworks. It says the bendy spacetime continuum described by general relativity is really a quantum system of particles in disguise. Spacetime and gravity emerge from quantum effects much as a 3D hologram projects out of a 2D pattern.[1082]

Effectively, this means that exformation causes time and space.

The holographic principle is based on AdS/CFT correspondence,[1083] Mark Van Raamsdonk suggested that spacetime arises as an emergent phenomenon of the quantum degrees of freedom that are entangled and live in the boundary of the spacetime. Entanglement lives in a two-dimensional CFT world. If we call that a quantum bit, a qubit, what will happen if we combine multiple, two-dimensional CFT worlds? If there were enough qubits Mark Van Raamsdonk tells us we could induce gravity, more precisely anti-gravity, in the AdS world.[1084]

> Theories of holographic duality feature a correspondence between a gravitational system and a strongly interacting conformal field theory (CFT) living on the system's boundary.

> Through this correspondence, the CFT encodes the geometry of spacetime in the gravitational system. Van Raamsdonk analyzed the role of entanglement in this theoretical framework. Instead of considering a single CFT, the author's starting point was a collection of CFT “bits” that are mutually entangled but do not interact with one another. The spacetime that these bits collectively encode was then shown to be arbitrarily close to the one encoded by the original CFT, suggesting that entanglement plays a crucial role in the emergence of spacetime.[1085]

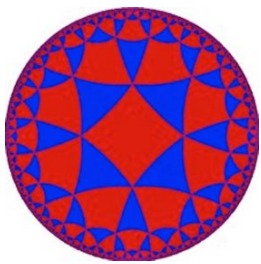
This would show the connection between the two-dimensional surface referred to here is a boundary condition and the three-dimensional volume of geometric curvature. In my musings, could time be the higher order dimensioning or degrees of freedom of the effect we call the quantum wave function? In any case, the 2-D entangled quantum boundary describes everything in what we perceive as in 3-D spatial volume. This is referred to as holographic duality. MIT tells us,

> Holographic dualities give both a new perspective into quantum gravitational phenomena as encoded in quantum field theory, and a way to explore aspects of strongly coupled field theories using the gravitational dual. CTP faculty have played a pioneering role in several applications of holographic duality. Hong Liu and Krishna Rajagopal are at the forefront of efforts that use holography to find new insights into the physics of the quark-gluon plasma. Liu was among the first to point out possible connections between blackhole physics and the strange metal phase of high temperature superconductors, and in recent years has been combining insights from effective field theories, holography, and condensed matter physics to address various issues concerning far-from-equilibrium systems including superfluid

turbulence, entanglement growth, quantum chaos, thermalization, and a complete formulation of fluctuating hydrodynamics.[1086]

The next section is a deeper dive into how these CFT 'bits' could stack up to produce quantum gravity in a more visual explanation.

A Deeper Dive - Geometric unity of quantum gravity



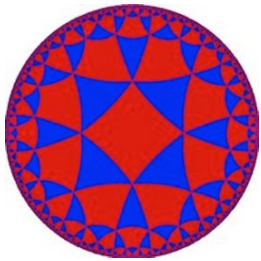
[1087]

Let's look at this from a geometry point of view. Normally we think of a 3D coordinate system as simple x, y, and z axes which are orthogonal to each other, at 90 degrees from each other. This would be like flat geometry. Remember this,

Triangles on shapes with positive curvature have angles which add to more than 180 degrees. Triangles on shapes with negative curvature have angles which add to less than 180 degrees. Triangles on shapes with no curvature are our familiar 180 degree types. Pythagoras' theorem no longer holds, and circles no longer have pi as a ratio of their circumference and diameter outside of non-curved space.

Gaussian space has positive curved geometry. Hyperbolic space has negative curved geometry. AdS (anti-de Sitter) is hyperbolic space and dS (de Sitter) space is gaussian. In the image below, if you placed identical triangles symmetrically all over the surface of a hyperbolic curve (like a well) and then straightened the surface out

to be like a 2D sheet of paper, the resulting curved triangles which also make up curved squares would be like the diagram below. This is mathematically called tessellation (umm, remember fractal shapes?).



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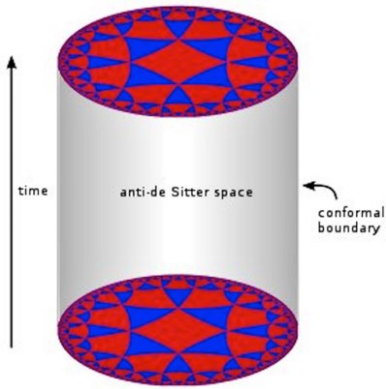
Now let's take a whole stack of these tessellated hyperbolic disk shapes (CFT bits) and stack them on top of each other. These hyperbolic disks stacked on each other would make a cylinder. This image shows this tessellated image. One can define the distance between points of this disk in such a way that all the triangles and squares are the same size, and the circular outer boundary is infinitely far from any point in the interior.

Now imagine a stack of hyperbolic disks where each disk represents the state of the universe at a given time. The resulting geometric object is a three-dimensional anti-de Sitter space. It looks like a solid cylinder in which any cross section is a copy of the hyperbolic disk. Time runs along the vertical direction in this picture. The surface of this cylinder plays an important role in the AdS/CFT correspondence.



1089

As with the hyperbolic plane, anti-de Sitter space is curved in such a way that any point in the interior is actually infinitely far from this boundary surface.[1090] Now imagine a stack of hyperbolic disks where each disk represents the state of the universe at a given time. The resulting geometric object is a three-dimensional anti-de Sitter space. It looks like a solid cylinder in which any cross section is a copy of the hyperbolic disk. Time runs along the vertical direction in this picture. The surface of this cylinder plays an important role in the AdS/CFT correspondence.

This construction describes a hypothetical universe with only two space and one time dimension, but it can be generalized to any number of dimensions. Indeed, hyperbolic space can have more than two dimensions and one can "stack up" copies of hyperbolic space to get higher-dimensional models of anti-de Sitter space.

An important feature of CFT space is its 2D boundary which encodes information about 3D AdS space. Visualize the background quantum vacuum energy of 2D CFT as circular slices stacked on each other to make a 3D cylinder.

The 3D cylinder is AdS which describes three-dimensional anti-de Sitter space. One property of this boundary is that, locally around any point, it looks just like Minkowski space, the model of spacetime used in non-gravitational physics.

> In Minkowski space, the conformal group does not preserve causality. Observables such as correlation functions are invariant under the conformal algebra, but not under the conformal group. As shown by Lüscher and Mack, it is possible to restore the invariance under the conformal group by extending the flat Minkowski space into a Lorentzian cylinder.[8] The original Minkowski space is conformally equivalent to a region of the cylinder called a Poincaré patch. In the cylinder, global conformal transformations do not violate causality: instead, they can move points outside the Poincaré patch.[1091]

An important feature of anti-de Sitter space is its boundary (which looks like a cylinder in the case of three-dimensional anti-de Sitter space). One property of this boundary is that, locally around any point, it looks just like Minkowski space, the model of spacetime used in non-gravitational physics.

One can therefore consider an auxiliary theory in which "spacetime" is given by the boundary of anti-de Sitter space. This observation is the starting point for AdS/CFT correspondence, which states that the boundary of anti-de Sitter space can be regarded as the "spacetime" for a CFT. The claim is that CFT is equivalent to the gravitational theory on the bulk anti-de Sitter space in the sense that there is a "dictionary" for translating calculations in one theory into calculations in the other. Every entity in one theory has a counterpart in the other theory. For example, a single particle in gravitational theory might correspond to some collection of particles in the boundary theory. In addition, the predictions in the two theories are quantitatively identical so that if two particles have a 40 percent chance of colliding in the gravitational theory, then the corresponding collections in the boundary theory would also have a 40 percent chance of colliding.

Notice that the boundary of anti-de Sitter space has fewer dimensions than anti-de Sitter space itself. For instance, in the

three-dimensional example illustrated above, the boundary is a two-dimensional surface. The AdS/CFT correspondence is often described as a "holographic duality" because this relationship between the two theories is similar to the relationship between a three-dimensional object and its image as a hologram. Although a hologram is two-dimensional, it encodes information about all three dimensions of the object it represents. In the same way, theories which are related by the AdS/CFT correspondence are conjectured to be exactly equivalent, despite living in different numbers of dimensions. Conformal field theory is like a hologram which captures information about the higher-dimensional quantum gravity theory.[1092] Also, check the previous footnote for some excellent more general discussions of this topic.

A Deeper Dive - Semiclassical Entangled Entropy

I touched on semiclassical explanations for entangled entropy. I mentioned entanglement itself is believed to be related to entropy upon wave function collapse. Therefore, entangled entropy is the semiclassical explanation for entropy. One crucial property of entanglement entropy in this context is known as strong subadditivity. This property requires that the entanglement entropy be a concave function with respect to geometric parameters. In other words, it ensures that combining subsystems does not increase the total entanglement entropy more than expected. [1093] Concave surfaces have negative curvature. This is important since in quantum field theory spacetime curvature influences the behavior of quantum fields. Even more so, entangled entropy *depends* on the geometry of the entangled surface. Entangled entropy is related to the area of the minimal surface area. For positive curvature geometries the entanglement entropy is related to the area of the minimal surface that bounds the entangled region. For convex surfaces, the area law ensures a finite entanglement entropy. However, for negative curvature geometries the entanglement

entropy can exhibit different behavior. For concave surfaces, the behavior can be more complex. In some cases, it remains finite due to cancellations (asymptotic), while in others, it diverges (goes to infinity).

For example, in AdS/CFT correspondence, a duality between a gravitational theory in Anti-de Sitter (AdS) space and a conformal field theory (CFT) in one fewer dimension, the entanglement entropy scales differently. The entanglement entropy in the CFT corresponds to the area of a minimal surface in the AdS space. For certain entangling regions, the minimal surface can extend into the bulk AdS region, leading to an entanglement entropy that scales with the volume rather than just the area. To delve deeper into entangled entropy, here are some main points:

- The AdS/CFT correspondence duality relates a CFT in d dimensions to AdS quantum gravity in $(d+1)$ dimensions. It provides a powerful tool for studying strongly coupled field theories by mapping them to classical gravity theories in higher dimensions. 1094
- In the context of AdS/CFT, the entanglement entropy measures the entanglement between different regions of the CFT. It quantifies how much information is shared between subsystems. Strong subadditivity ensures that combining subsystems does not lead to unexpected increases in entanglement entropy.
- The holographic computation of entanglement entropy involves calculating it using the AdS/CFT dictionary. This approach allows us to explore the entanglement properties of strongly coupled gauge theories by analyzing their dual gravitational descriptions in AdS spacetime.
- Interestingly, there is a conjecture that Wilson loop correlators in strongly coupled gauge theories satisfy the same strong subadditivity relation as the holographic

entanglement entropy. This connection highlights the deep interplay between entanglement and gauge theory observables. [1095]

The Holographic Duality, Entanglement, Qubits, and Blackholes

Actually, the holographic principle is better stated as any lower dimensional geometry encodes information to a higher dimensional geometry where for simplicity, we can say the lower dimensional geometry plus one is equal to the higher dimensional geometry.

In the Conformal Field Theory (CFT) side of the duality, gravity is mathematically absent. This reflects the Standard Model's approach, where quantum fields are calculated on a fixed, flat background without gravitational curvature.

The Holographic Principle typically relates a boundary of N dimensions to a bulk of N + 1 dimensions. Just as a 2D hologram encodes a 3D image, a 4D quantum field theory might encode a **5D** gravitational universe (as seen in Maldacena's AdS/CFT correspondence).

Stated simply: a lower-dimensional geometry encodes the information of a higher-dimensional geometry. For example, a 2D surface encodes the information of a 3D volume. If we apply this to the cosmos, a 3D boundary (like the event horizon of a black hole) could encode the information of the 4D spacetime within.

If we step into Superstring Theory, the math requires ten dimensions (nine spatial dimensions plus time). The six extra dimensions are 'curled up' (compactified), which goes a long way toward explaining bizarre quantum effects and the values of fundamental constants. Finally, if we go the route of M-Theory, we need eleven dimensions (ten spatial plus time), a framework that unifies the various string theories not by 'encoding' them, but by revealing them as different limits of a single, higher-dimensional structure.

For this we will KISS (keep it simple stupid – a great philosophy

of life or at least a noble goal). Let's take the surface area of the universe. Keep in mind it could be the event horizon of a blackhole, the zero and one of a qubit, on any entangled particle, system, or x. Yes, that's right entanglement is a form of encoding! Not all entanglement is the same. There is short lived entanglement decohering quickly like at normal room temperatures. In fact, more heat, more entropy means higher temperatures. Just like when our temper goes up, we get pissier and snap quicker. When we are cool, calm and collected everything is groovy. If we cool entanglement down do near zero Kelvin, we can actually use entanglement more constructively. And in the quantum wave function entanglement never decoheres, it just incessantly emerges in novel fashions without any emergent notion like temporality overseeing the entire operation. Whether in the wave function or everyday life there is this duality of the wave function and decoherence. But entanglement has density. In other words, they can be more or less entanglement stuffed into the same region. How does this happen? In a word encoding, encoded exformation.

As I have mentioned curved space has to do with entangled density. The more entangled exformation, the more space is curved. And as we all know the classical word for this is gravity. The less encoded density, perhaps we have zero-point energy, vacuum space. So, somewhere on the less-dimensional surface there is encoded information which is denser. Perhaps, this results in curving spacetime to higher dimensions. Might it be that the more twisted and deformed curves we get in spacetime, the more rolled up dimensions we need to deal with or better, new degrees of freedom. And, if we go too far, we get a singularity which is really past the limit of spacetime and for all intents and purposes back to the quantum wave function (call the wave function universal, universal**s,** bosonic (e.g., light) or what I prefer quantum chaos). But there is more.

This holographic principle works with relativity or quantum physics. On the less dimensional encoded geometry, the higher

density, entangled encoding results in quantum field theory. Higher density is stronger coupling (for simplicity think high entanglement density). This coupling occurs at higher energies. From our frequency spectrum we know that higher energies increase until we get to massless particles like photons which are extremely high energies. At these energies physicists use a fancy phrase. They say perturbation theory breaks down – oooh scary word. Not really, how many times a day do you get perturbed? What they are saying is that things get so (quantum) chaotic the train goes off the rails. Things get spooky, hard to predict, and classicism gets swallowed up by the void.

On the other (dualist, complementarity) hand, weaker coupling on the one less dimensional geometry may have some relation to less entangled density. Physicists say this works well with perturbative theory, established quantum mechanics that we have found in particle accelerators. In this case, quantum field theory (QFT) which likes to play with Einstein's general relativity (AdS or dS for general relativity) is just what the headache doctor ordered. Less density entangled encoding likes to work with our standard, boiler plate quantum mechanics. Physicists specifically call this gauge theory (CFT).

Anti-de Sitter (AdS) is a type of mathematics which wants to play with relativity and quantum field theory. Conformal Field Theory likes to play with quantum mechanics or gauge theories. And the hologram is a perfect metaphor for how all this hangs together. This is about as simple as I know to make it, and I hope no physicist wants to grade me on it. But the really cool thing is that the holographic principle does not care about scale of absolute dimensions. It is all relative. It can apply to the universe, multiple universes, blackholes, singularities, Big Bangs, qubits, etc. And the part that makes me want to jump for joy (I know I am weird) is that all this is happening as complementarity to the quantum wave function! If this is not an ABSOLUTE tribute to life, beauty, and wonder we must have our head stuck in the sands of time. We

really need to get over ourselves and smell the quantum flowers! [1096]

Holographic Loop Quantum Gravity

While the holographic principle has promising results about our universe, we can expand the idea of encoded information to the idea, could there be other encodings? Why can't encoding be taken up into descriptions of other 'laws of physics'? Our universe is analogous to an encoded landscape. Why can't other codes produce other landscapes? There is no reason this could not be. This is the idea of many-worlds or that which goes all the way back to many ancient cultures including the ancient Greeks or the multiverses today. This kind of encoding and decoding has also been called the butterfly effect.

For now, I want to return to quantum gravity and how quantum gravity has found a compatibility within Einstein's relativity. Loop quantum gravity already discussed in the section entitled, "Loop Quantum Gravity" is an extension of Einstein's general relativity that quantizes spacetime. It also predicts that white holes are evolved from black holes. A white hole is the opposite of a blackhole. Instead of swallowing up large amounts of matter it spits out large amounts of matter.

> Abhay Ashtekar and Javier Olmedo at Pennsylvania State University in University Park and Parampreet Singh at Louisiana State University, Baton Rouge, have taken a step toward answering this question. They have shown that loop quantum gravity—a candidate theory for providing a quantum-mechanical description of gravity—predicts that spacetime continues across the center of the hole into a new region that exists in the future and has the geometry of the interior of a white hole. A white hole is the time-reversed image of a blackhole: in it, matter can only move outwards.

> The passage “across the center” into a future region is counterintuitive; it is possible thanks to the strong distortion of the spacetime geometry inside the hole that is allowed by general relativity. This result supports a hypothesis under investigation by numerous research groups: the future of all blackholes may be to convert into a real white hole, from which the matter that has fallen inside can bounce out. However, existing theories have not been able to fully show a way for this bounce to happen. That loop quantum gravity manages to do it is an indication that this theory has ripened enough to tackle real-world situations.[1097]

A singularity in relativity is really a mathematical infinity. For physicists this is an anathema. There are currently alternate ideas about singularities surfacing. Loop quantum gravity might be a way to avoid the notion of singularity. Our Big Bang might be an example of a white hole.

> Alternatively, the aftermath of a white hole may exist everywhere. To blackhole physicists, the Big Bang's explosion of matter and energy looks like potential white hole behavior. "The geometry is very similar in the two cases," Haggard said. "Even to the point of being mathematically identical at times."
>
> Cosmologists call this picture the "the Big Bounce," and some seek characteristic white hole features in the universe's earliest observable light. Rovelli also wonders if violent radio bursts represent the cries of theoretical mini blackholes left over from the Big Bang as they make an early transition into white holes (although this explanation appears increasingly unlikely).[1098]

For now, white holes are only theoretical. However, with some *ad hoc* modifications to Einstein’s general relativity equation, loop

quantum gravity does allow for the existence of white holes.[1099]

Many Worlds

In the 5th century BC, Atomists and the Stoics believed that the cosmos' *peras* (order, form, boundary, limit) and *kallos* (beauty) were *simvevikós* (accidental). Atoms colliding in *apeiron* (unlimited, without form, void, chaos) resulted in an endless number of other parallel worlds inferior to our world. The Stoics did not attribute this to atoms. They thought the cosmos was pneuma (*apeiron* or unlimited breath, spirit, soul). Later in the 3rd century BC, the Stoics stated that the cosmos cycled endlessly between *apeiron* (unlimited, without form, void, chaos) and peras (order, form, boundary, limit).[1100] One of the proponents of many worlds was Democritus (460-370 BC),

> Democritus held that originally the universe was composed of nothing but tiny atoms churning in chaos, until they collided together to form larger units—including the earth and everything on it. He surmised that there are many worlds, some growing, some decaying; some with no sun or moon, some with several. He held that every world has a beginning and an end and that a world could be destroyed by collision with another world.[1101]

In the 20th century, physics M-Theory became very popular as various mathematical string theories' unification (superstring theory). I think the best definition of 'M' in M-Theory is membrane (think of biology). Many universes in multiple dimensions were analogous to biological membranes in living organisms. These 'organisms' were like landscapes.

> There are many conjectures about what M stood for. Here are some of the possibilities: mother, miracle, membrane,

> magic, mysterious, and master. Later, matrix was added. No one seems to know for sure what Witten had in mind when he coined the term M-theory. Unlike the previously known five theories, the new cousin is not a theory with nine space dimensions and one time. Instead, it is a theory with ten dimensions of space and one of time. Even more alarming, M-theory is not a theory of strings: the basic objects of M-theory are membranes, two-dimensional sheets of energy that resemble elastic sheets of rubber instead of one-dimensional rubber bands. The good news was that M-theory seemed to provide a unifying framework in which the various String Theories appear when one or more of the ten dimensions of space are rolled up by compactification. This was real progress that held the promise of a unifying foundation for String Theory. [1102]

To start this discussion, we first need to talk about Susskind's book "The Cosmic Landscape" and a very important constant which is also probably the most embarrassing problem in modern physics - the cosmological constant. Einstein proposed this constant in his formulas with the Greek letter lambda. It was not called the cosmological constant then. He put this variable in his equations essentially to make relativity's formulas work out. It makes the theory of relativity work out with a static universe, not expanding or contracting.

> Einstein first proposed the cosmological constant (not to be confused with the Hubble Constant) usually symbolized by the Greek letter "lambda" (Λ), as a mathematical fix to the theory of general relativity.[1103]

For Einstein, lambda was set to a positive value to make a repulsive force which made the universe stable so it would not expand or contract. Gravity is an attractive force which causes the

universe to contract. Without the lambda constant the universe would collapse in on itself. Einstein thought the universe was static, not expanding or contracting and set lambda accordingly. Einstein thought the cosmological constant was his greatest blunder.

Cosmological Constant

As it turned out, years later while Einstein was still alive Hubble discovered the universe was expanding. This required a change to the lambda constant to keep relativity kosher. Einstein's greatest blunder turned out to be one of his greatest successes. This constant is due to what is called the vacuum energy (which is not really a vacuum, but the term stuck) of the universe. It is also thought to be closely associated with dark energy.

> Long ago, when Einstein was still experimenting with the cosmological constant, the Dutch astronomer Willem de Sitter began the study of inflating space. The space or, more accurately, space-time that de Sitter discovered, and which carries his name, is the solution to Einstein's equations when there is no energy or gravitating matter other than the ubiquitous vacuum energy of empty space, i.e., a cosmological constant. Like Einstein, de Sitter assumed the cosmological constant was positive. What he found was an inflating space that grows exponentially with time. Exponential expansion means that in a certain time interval space doubles; then, in the next time interval, it doubles again; and then again. It grows to two times—four times—eight times—sixteen times its original size, in the same way that compound interest expands money. At a rate of 5 percent interest, your capital would double in fourteen years. The cosmological constant is like the interest rate: the bigger the cosmological constant, the faster the space inflates. Like any expanding space, de Sitter space satisfies Hubble's Law—

velocity proportional to distance. [1104](Susskind, 2008, p. 298)

Vacuum energy is ubiquitous all over the universe. It is 'empty' space which is not really empty. It is where virtual particles popping in and out of existence live.

> In every bit of nothing, there is something. If you zoom in on empty space and take out all the planets and stars and galaxies, you might expect a pure vacuum, but you'd be wrong. Instead you would find a dynamic scene, with particles sparking to life and disappearing almost immediately.
>
> Quantum mechanics, the theory governing the infinitesimal world, doesn't allow for nothingness. At any given moment in time and space, energy can never be perfectly zero—there is always some wiggle room. Out of that wiggle room, "virtual" particles can arise—specifically, a pair made of a particle and its antiparticle, which annihilate each other and are gone as quickly as they came. As bizarre as this may seem, experiments have observed the real-world effects of virtual particles.[1105]

The cosmological constant is due to the not-so-emptiness of space which accounts for the expansion of the universe.

> The effect of all these particles wiggling into and out of being is a thrumming "vacuum energy" that fills the cosmos and pushes outward on space itself. This activity is the most likely explanation for dark energy—the reason the universe, rather than staying static or even expanding at a steady rate, is accelerating outward faster and faster every moment.[1106]

The latest twist on this saga was when the discovery that the

universe was not just expanding at a constant rate but accelerating the expansion of the universe. Enter dark energy,

> In the late 1990s two teams of astronomers were competing to measure how much the expansion of the universe was slowing down as a result of gravity pulling matter inward. In 1998 and 1999 they published their results, based on measurements of special supernovae whose distances could be determined very accurately. The most distant of these supernovae turned out to be much dimmer, and therefore farther away, than expected. The expansion wasn't slowing down at all—it was speeding up. This alarming discovery won three of the teams' leaders a Nobel Prize and prompted cosmologist Michael Turner to coin the term “dark energy” for the mysterious force causing the acceleration. Immediately physicists suggested that the source of dark energy might be the cosmological constant—in other words, vacuum energy. “Perhaps there was more insight in Einstein's blunder than in the best efforts of ordinary mortals,” Saul Perlmutter, one of the discoverers of the acceleration, later wrote.[1107]

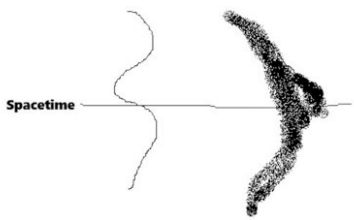
Finally, here are some other important reasons why the cosmological constant is needed.

> There are a number of other observations that are suggestive of the need for a cosmological constant. For example, if the cosmological constant today comprises most of the energy density of the universe, then the extrapolated age of the universe is much larger than it would be without such a term, which helps avoid the dilemma that the extrapolated age of the universe is younger than some of the oldest stars we observe! A cosmological constant term added to the standard model Big Bang theory leads to a model that

> appears to be consistent with the observed large-scale distribution of galaxies and clusters, with WMAP's measurements of cosmic microwave background fluctuations, and with the observed properties of X-ray clusters.[1108]

The cosmological constant will come up again in the discussion of strings and branes. However, let's get back now to the well-established math of the mathematics of general relativity's space - de Sitter space.

Strings and Branes



[1109]

Spacetime with Strings Intersecting as Point-Particles and Branes Intersecting as Regions or Landscapes

Ok, buckle up for this section. I will do my best to articulate this really complex work in quantum physics which started in earnest in the sixties. This topic is mathematical and has been through many permutations and downright collapses as well. However, it still remains mathematically usable and necessary for much of the current work in quantum physics, more particularly, in quantum gravity. Why do we need to go towards increasing complexity in mathematics?

> Relativity gives nonsensical answers when you try to scale it down to quantum size, eventually descending to infinite values in its description of gravity. Likewise, quantum

> mechanics runs into serious trouble when you blow it up to cosmic dimensions. Quantum fields carry a certain amount of energy, even in seemingly empty space, and the amount of energy gets bigger as the fields get bigger. According to Einstein, energy and mass are equivalent (that's the message of E=mc2), so piling up energy is exactly like piling up mass. Go big enough, and the amount of energy in the quantum fields becomes so great that it creates a blackhole that causes the universe to fold in on itself. Oops.[1110]

Einstein's Sheets of Spacetime Bent Back on Each Other

Einstein's general theory of relativity focused on sheets of spacetime which could be bent back on itself. We now call this a blackhole. Oddly, there are many reasons why our current universe looks a lot like a blackhole. Blackholes are huge gravitational objects and, in their singularity, decompose everything which goes into them into the Planck levels of quanta. This means blackholes are converters of the very large to the very small. The interesting thing about blackholes is that how they look from the outside and how they look from the inside are extremely different in the same way that quanta look like particles and waves – can we think contradictorily? Similarly, the smooth descriptions of gravity in relativity and the chunky descriptions of quanta in quantum physics have highly different descriptions of the universe. Bohr's idea of complementarity looks increasingly like a common theme that keeps coming up in physics. This section is going to try to convey my understanding of some of the most mind-bending ideas going on in quantum physics.

> Basically, Einstein realized that space is much more than the "space" we live in and that time transcends the clocks we've invented. Rather, he theorized, the two are physically entangled.

> Space is like a canvas on which our past, present and future are woven -- and it can fold, twist and ripple like silk. There's no beginning or end to this fabric of space and time, or as he called it, spacetime.
>
> We can't exactly see the spacetime continuum because it's part of a realm imperceptible to human eyes: the fourth dimension. But we can deduce its existence, as we can feel its effects. One of those effects you're no doubt familiar with -- gravity. But there are other effects too, like time moving slower depending on where you are in the universe and space-borne magnifying glass phenomena dubbed gravitational lensing.[1111]

Point-like Particles

The idea of a point-like particle seems to historically recur more often than not in cutting edge research. We used to think atoms were point-like. Then, we thought electrons, protons, and neutrons were point-like. If we drill down to our current point-like particles that fall into categories called quarks, leptons, and bosons. Quarks, leptons, and bosons are categories of quanta not actual names for a single particle. Since the particles which make up these kinds of quanta have largely been discovered using cutting edge particle accelerators, there is some tendency to treat them as point-like. These current point-like particles make up all the higher order particles such as electrons, protons, neutrons, basically everything else. At this level it gets really complicated.

> At our current level of understanding, the elementary particles are quarks, leptons (such as the electron) and bosons (such as the photon). These particles are all imagined as pointlike, so you might wonder how they can have spins. A simple answer might be, perhaps they are composite, too. But deep theoretical reasons having to do with the rotational

> symmetry of nature lead to the existence of spins for elementary objects and to their quantization.[1112]

Looking below the covers of these point-like particles are getting closer to Planck sizes. These sizes would require particle accelerators the size of our solar system to see what happens to them directly so that is not an option. However, there are indirect ways we can make discoveries. We already talked about the noise in gravitational waves which travel at the speed of light as a way we may be able to verify that the graviton exists. Much of this kind of work by necessity will be mathematical.

At this level we are getting into the mathematics of string theory or branes (pick your poison). A 'brane' is short for 'membrane'. Remember the discussion about geometry in the beginning? Strings and branes are geometric shapes which can be as simple as squiggly lines, circles, and spheres. Conservatively, these geometric shapes go well into the millions. Most of these shapes could never be visualized. However, the mathematics created for string theory and the multiverse can describe these shapes very well. The mathematics of these shapes use higher dimensions in addition to the four dimensions of spacetime Einstein wrote about. These higher dimensions can start around six more for a total of ten dimensions and go up from there. These additional dimensions can be compacted to Planck levels so we would see them as point-like in our spacetime. Here is how Susskind explains how physics arrives at dimensions greater than the four of spacetime:

> Einstein and Friedmann were imagining space to be a gigantic sphere, big enough to move around in for billions of years without encountering the same galaxy or star twice. But now imagine shrinking the sphere smaller and smaller until it is far too small to hold a human being or even a molecule, an atom or even a proton. If the 2-sphere is shrunken to microscopic proportions, it becomes hard to

distinguish it from a point—a space with no dimensions to move in. This is the simplest example of hiding dimensions by compactifying, or shrinking, them.

Can we somehow choose the shape of a two-dimensional space so that it looks for most purposes like a one-dimensional space? Can we effectively hide one of the two dimensions of the sheet of paper? Indeed, we can. Here's how you do it: Start with an imaginary infinite sheet of paper. Cut out an infinite strip a few inches wide. Let's say the strip is along the x-axis. The tip of your pencil can move forever along the x-axis, but if you move it in the y-direction, you'll soon come to one of the edges. Now take the strip and bend it into a cylinder so that the upper and lower edges are joined in a smooth seam. The result is an infinite cylinder that can be described as compact (finite) in the y-direction, but infinite in the x-direction. [1113]

Let's imagine such a space, but instead of making the y-direction a few inches in circumference, let's take it to be a micron (one ten-thousandth of a centimeter). If we looked at the cylinder without a microscope, it would look like a one-dimensional space, an infinitely thin "hair." Only if we look through a microscope will it reveal itself to be two-dimensional. In this way a two-dimensional space is disguised as one-dimensional.

Suppose we further reduce the size of the compact direction all the way down to the Planck length. Then no existing microscope would be able to resolve the second dimension. For all practical purposes the space would be one-dimensional. This process of making some directions finite and leaving the rest infinite is called compactification. [1114](Susskind, 2008, pp. 231-232)

So, these compacted dimensions would look like a point particle

to us! We could never unravel this point particle except in math. As it so happens, even though we could never 'see' what makes up this compacted point particle, we could use this math to predict all kinds of properties we see in the smallest point particles we can see. If this math explains how properties like spin, momentum, etc. can have statistically significant predictability, then math is useful no matter how impossible it might be to 'see' or visualize further into the point particle. This is how string theory and branes still make sense in physics. Some of its early predictions were wrong but the math is still very useful.

Compactification

Let's recall these four constants:

- The speed of light (c = 186,282 miles per second)
- The gravitational constant ($G = 6.674 \times 10^{-11}$ $m^3 \cdot kg^{-1} \cdot s^{-2}$)
- The reduced Planck constant ($\hbar = 6.62607015 \times 10 - 34$ joule-hertz $- 1$)
- The Boltzmann constant ($k_b = 1.380649 \times 10 - 23$ joule per kelvin). [1115]

It may have occurred to you, "Where do these constants come from?" It turns out that compactification also explains how these constants come about. Susskind tells us,

> Back to the two-dimensional cylinder. The distance around the cylinder is called the compactification scale. For a cardboard cylinder it might be a few inches, but for String Theory it should most likely be a few Planck lengths. You might think that this scale is so small that it doesn't matter for anything we care about, but that's not so. Although we can't actually see such small scales, they nonetheless have

> their effect on ordinary physics. The compactification scale in Kaluza's theory fixes the magnitude of the electric charge of a particle like the electron. It also fixes the masses of many of the particles. In other words the scale of compactification determines various constants that appear in the ordinary Laws of Physics. Vary the size of the cylinder, and the Laws of Physics change. Vary the values of scalar fields as in chapter 1, and the Laws of Physics change. Is there a connection? Absolutely! [1116]

So, as these extra compacted dimensions vary in scale, so do the 'laws of physics'. This enables the math of strings and branes to tell us various kinds of universe where life could exist as we know it and where it could not exist. It can also tell us how dark energy and dark matter might work. We would also be able to see how potential universes could unfold or collapse immediately. This is not to say that we could ever know about these other universes, but the question remains that if string and brane math explains fundamental laws of physics in our universe, what is to stop other universes from existing, and how might they overlap in our universe? Additionally, for us, how might they overlap in our universe that would give us useful information about our universe. With that in mind, let's look at gravity.

Landscapes

From our discussion on the cosmological constant, we saw that a positive cosmological constant is expansive. A negative cosmological constant is attractive. But wait, gravity is attractive. The various geometries of strings and branes produce and vary these odd universal constants. So, what do you think happens if the cosmological constant is zero - in a word supersymmetry.

You might recall what quantum physics calls the Standard Model. These make up the smallest particles we know of which

account for everything in the universe. The Higgs Boson was predicted and years later discovered. What would happen if every one of these particles had an equal and opposite partner?

> But sometime in the early 1970s, as a consequence of discoveries by string theorists, physicists began to play around with a new mathematical idea, the idea that fermions and bosons are not really so different. The idea is that all particles come in precisely matched pairs, identical twins that are the same in every way except that one is a fermion and one is a boson. This was a wild hypothesis. If true in the real world, it would mean that physicists had completely missed half the particles of nature, had failed to discover them in their labs. For example, this new principle would require that there is a particle exactly like the electron—same mass and charge—except that it would be a boson. How could we have failed to detect it in particle physics laboratories like SLAC and CERN? Supersymmetry implies that a fermion twin for the photon, massless and with no electric charge, would have to exist. Similarly, boson partners for electrons and quarks would be required. A complete world of "opposites" was mysteriously missing if this new idea were right. In fact the whole exercise was only a mathematical game, a pure theoretical exploration of a new kind of symmetry that a world—some world not our own—might possess. 1117

Supersymmetry has been proven not to exist in our universe as a whole, which was the big gotcha which gave some string theorists seemingly egg on their face decades ago. However, supersymmetry could exist in pockets in our universe called hidden valleys.

> Unlike normal matter, dark matter does not interact with the electromagnetic force. This means it does not absorb, reflect

or emit light, making it extremely hard to spot. In fact, researchers have been able to infer the existence of dark matter only from the gravitational effect it seems to have on visible matter. Dark matter seems to outweigh visible matter roughly six to one, making up about 27% of the universe. Here's a sobering fact: The matter we know and that makes up all stars and galaxies only accounts for 5% of the content of the universe! But what is dark matter? One idea is that it could contain "supersymmetric particles" – hypothesized particles that are partners to those already known in the Standard Model. Experiments at the Large Hadron Collider (LHC) may provide more direct clues about dark matter.

Many theories say the dark matter particles would be light enough to be produced at the LHC. If they were created at the LHC, they would escape through the detectors unnoticed. However, they would carry away energy and momentum, so physicists could infer their existence from the amount of energy and momentum “missing” after a collision. Dark matter candidates arise frequently in theories that suggest physics beyond the Standard Model, such as supersymmetry and extra dimensions. One theory suggests the existence of a “Hidden Valley”, a parallel world made of dark matter having very little in common with matter we know. If one of these theories proved to be true, it could help scientists gain a better understanding of the composition of our universe and, in particular, how galaxies hold together.[1118]

Supersymmetry could also exist in another universe and guess what - the cosmological constant in that universe would be zero. A supersymmetric universe would probably be made up of dark matter. This would be Einstein's static universe - not expanding or contracting, perfectly in balance or supersymmetric. Even though our universe was not supersymmetric, what came out of

supersymmetry greatly simplified very complicated problems we have in our universe.

> The identical twins don't exist. Physicists didn't blunder and miss a whole parallel world. Why, then, is there interest in such idle mathematical speculation—interest that has only intensified over the last thirty years? Physicists are always interested in possible mathematical symmetries, even if the only question is why they aren't part of nature. But also both the real world and the physicist's description of it are full of symmetry. Symmetry is one of the most far-reaching and powerful weapons in the arsenal of theoretical physics. It permeates every branch of modern physics, particularly those that have to do with quantum mechanics. In many cases all we really know about a physical system is its symmetries, but so powerful are these symmetries that they sometimes tell us almost everything we want to know. Symmetries are often at the core of what physicists find esthetically pleasing about their theories. But what are they?
>
> Let's begin with a snowflake. Every child knows that no two snowflakes are exactly alike, but they nevertheless all share a certain feature: a symmetry. Just looking at a snowflake, you can easily see its symmetry. Take the snowflake and rotate it by an angle. It will look different, tilted. But if you rotate it by exactly 60 degrees, it will look unchanged. A physicist would say that rotating a snowflake through 60 degrees is a symmetry. [1119]

To make a long story shorter, one critical area where string theory shines is, you guessed it, gravity. After the early hectic times of string theory five theories remained. These five theories were distilled from many earlier variants and quite unexpectedly distilled into five essential theories. As it turns out these five theories describe the oddly weak and very strange force we call gravity.

> By 1985 String Theory—now called superString Theory—had five distinct versions. They differed in a number of ways. Two had open strings (strings with two ends) as well as closed strings—three did not. The names of the five are not particularly enlightening, but here they are. The two with open strings are called Type Ia and Ib String Theories. The remaining three with only closed strings are known as Type IIa, Type IIb, and Heterotic String Theories. The distinctions are too technical to describe without boring the reader. But one thing that they have in common is far more interesting than any of the differences: although some have open strings and some don't, all five versions have closed strings…
>
> But the five String Theories are very clear on this point: they simply cannot be formulated without gravity. Gravity is not an arbitrary input—it is an inevitable outcome. String Theory, in order to be consistent, must include the graviton and the forces that it mediates by exchange. The reason is simple. The graviton is a closed string, the lightest one. Open strings are optional, but closed strings are always there. Suppose we try to create a theory with only open strings. If we succeed we will have a String Theory without gravity. But we will always fail. The two ends of an open string can always find each other and join to form a closed string. Ordinary theories are consistent only if gravity is left out. String Theory is consistent only if it includes gravity. That fact, more than any other, gives string theorists confidence that they are on the right track. [1120]

The discussion below is going to delve into string and branes but before I do that, I want to explain why these mathematical models are important. Together these models are going to tell us how the laws of physics can come about various universes most importantly, including our own. They can go a long way explaining the Standard model and how various really small subatomic particles have

particular properties. They can also lay out landscapes of the universe which detail energy levels and, because of the Higgs Boson, their masses from everything to the vacuum energy of the universe to everything we see which is probably around four percent and everything which we cannot see like dark energy and dark matter. Landscapes can describe millions of universes which could be but most of them would not sustain life as we know it. They can also explain singularities like a blackhole, and reverse singularities called a white hole or better known as the Big Bang. Oh, because these universes have varying cosmological constants from negative to zero to positive universes can vary from very short life spans to static universes to very long lifespans and even with negative or anti-gravity (expansive) and attractive vacuum energy.

Metastable states can vastly change a landscape quickly. There are many examples of Metastable states. Cosmic inflation was one example of a metastable state. Here are a couple of others.

Metastable state: Negative Kelvin

Remember the findings earlier on entropy and one study concerning 'negative Kelvin'?[1121] Afterward, I read some criticisms of the experiment. The contention was that the energy at higher frequencies was artificially increased to very high levels causing a kind of over-saturation or in current terms metastable as water being liquid well below the temperature where it should freeze. So, yes, negative Kelvin is artificially produced in the lab, but the various landscapes of the universe create these kinds of meta-stabilities all the time. Could it be that the collapsing giant star which creates a blackhole is yet another case and point of a metastable environment?

> Water freezes solid at a temperature of 32 degrees Fahrenheit or, what is the same thing, zero degrees on the centigrade scale. However, you can cool very pure water to a lower

temperature without its becoming solid if you do it slowly and very carefully. Liquid water below freezing temperature is called supercooled.

Supercooled water, just below the usual freezing temperature, can last for a very long time. But introducing a small bit of ordinary ice will cause the water suddenly to crystallize around it and form a rapidly growing chunk of ice. Just as ice-nine [Kurt Vonnegut's novel, Cat's Cradle] destroyed the world, the real ice chunk will quickly take over the entire body of water.

Putting the ice crystal into the supercooled water is very similar to giving the rolling ball a shove over the nearby hill. It's the event that pushes the system "over the edge." In the case of the rolling ball, the shove has to be strong enough to push it over the barrier. A tiny push won't do it. The ball will just roll back to the starting position. The same is true for the supercooled water. If the ice crystal is smaller than a certain critical size, it will just melt back into the surrounding liquid. For example, an ice crystal just a few molecules in diameter will not grow and take over.

But even without someone adding a chip of ice, the supercooled water will not last forever. The reason is that the molecules in the liquid are constantly fluctuating, bouncing off one another and rearranging themselves. This motion is due to both the thermal jitters and the quantum jitters. Every once in a while, by accident, a group of molecules will arrange themselves into a small crystal. Most of the time the crystal will be so small that it will quickly melt into its surroundings.

Very rarely, however, a larger crystal will spontaneously form by random accident. Then the crystal will explosively grow, and everything will freeze. The phenomenon is called bubble nucleation, the growing ice crystal being thought of as an expanding bubble. A very similar thing will happen to

water that is superheated above the boiling point. The only difference is that a bubble of steam will spontaneously nucleate and grow.

The boundary between the solid ice and the liquid water (or the steam and water) is called a domain wall. It is like a membrane between the two different phases. In fact the domain wall has properties of its own, for example, surface tension that tries to shrink the bubble. Another example of a domain wall is the boundary between ordinary water and air. As a child I was fascinated by the trick of floating a steel sewing needle on the surface of a cup of water. The domain boundary separating air and water is like a skin stretched over the liquid. It has surface tension, which actually has to be pierced in order for an object to penetrate it.

A vacuum with a positive cosmological constant is a lot like a supercooled or superheated liquid. It is metastable and can decay by nucleating bubbles. Every vacuum corresponds to a valley in the Landscape with a particular altitude or energy density. However, although the vacuum may seem quiet and featureless to our coarse senses, quantum fluctuations continually create tiny bubbles of space whose properties correspond to neighboring valleys. Usually the bubbles quickly shrink and disappear. But if the neighboring valley has lower altitude, then every so often a bubble will appear that is large enough to start growing. Will it take over everything? We will see shortly.

The domain walls that separate a bubble from its environment are two-dimensional surfaces that resemble membranes. These are not the first membranes we have encountered. 1122

Metastable state: Quantum Tunneling

Quantum tunneling has been used many times in electronics such as

transistors. It is also used in quantum computing. Quantum tunneling is a lot like the supercooled water example given above. Normally, particles will not go through certain kinds of barriers. Most of the time they will not pass through these barriers. However, Schrödinger's equation tells us there is a slight probability that some of these particles will tunnel through the barrier. These particles tunnel very quickly through these variables. At one time it was thought that they passed through instantaneously. One experiment has shown that, for the experiment's barrier, it may have tunneled through at slightly less than the speed of light at $1.8 \text{ X } 10^{-18}$ seconds. Light travels the same distance at 10^{-21} seconds (from our inertial frame of reference). To think about the oddness of tunneling, think about the probability of a bowling ball tunneling through Mount Everest. Of course, that could not happen in the macro world but in the quantum world, vacuum energy has a small probability of adding just enough energy to make it through an otherwise impossible barrier.[1123]

Strings and Branes

String theory has nine space dimensions and one time dimension. In our universe of three dimensions of space and one of time, nine dimensions of space and one dimension of time, through the magic of compactification, collapses into one dimensional strings which vibrate through our universe. They may appear as a point particle in one place at a certain time and then almost immediately appear at a very different location. Strings can only collapse into one dimension in our universe if they have exactly nine dimensions of space and one dimension of time.

To make a shorter story short (hopefully), M-Theory can account for strings in terms of membranes and gravitons. Yes, gravitons which is the quantum particle comprising gravity. M-Theory provides a mathematical model for landscapes.

> The thing that makes these small segments of string so interesting is that they behave just like elementary particles. Take for example D3-branes. The short strings, with both ends attached to the brane, are free to move throughout the three-dimensional volume of the D-3 brane. They can come together, attach to form a single segment, vibrate, and disconnect. They move and interact just like the particles that String Theory was originally cooked up to explain. But now they live on a brane. The D-brane is a model of a world with elementary particles behaving much like the real elementary particles. The only thing missing on the D-brane is gravity. That's because the graviton is a closed string—a string with no ends. A string with no ends would not be stuck to the brane at all. Could the real world (with the exception of the graviton) of electrons, photons, and all the other elementary particles—as well as atoms, molecules, people, stars, and galaxies—all take place on a brane? To the majority of theorists working on these problems, it seems the most likely possibility. [1124]

One odd effect of String Theory is spacetime regeneration.

Spacetime Regeneration

Now we get to how a small area of space exponentially reproduces itself. Imagine an infinitely long hallway which can shrink or grow in width or height.

> Now comes a shocking and bizarre consequence of String Theory. If the width and height of the hallway get smaller than a certain size, a new dimension grows out of nowhere. This new direction of space is none of the ones we started with. We know about it only through the indirect mathematics of String Theory. The smaller we make the

> original compact directions, the bigger the newly created compact direction becomes. Eventually, as the hallway is shrunken to zero height and width, the new direction grows infinitely big. Astoundingly, by shrinking away two of the space dimensions, we find nine, not eight large directions left over. This peculiar fact—that "ten minus two equals nine"—is one of the strangest consequences of String Theory. The geometry of space is not always what Euclid or even Einstein thought. Evidently at the smallest distances, space is different from anything physicists or mathematicians imagined in their wildest dreams. 1125

Even more bizarre, M-Theory causes all these exponentially reproducing spaces to acquire landscapes, different laws of physics, different universes.

> What is it about String Theory that makes its Landscape so rich and diverse? The answer involves the enormous complexity of the tiny, rolled-up geometries that hide the extra six or seven dimensions of space. But before we get to this complexity, I want to explain a simpler and more familiar example of similar complexity. In fact this example was the original inspiration for the term Landscape.
>
> The term Landscape did not originate with string theorists or cosmologists. When I first used it in 2003 to describe the large number of String Theory vacuums, I was borrowing it from a much older field of science: the physics and chemistry of large molecules. The possible configurations of a large molecule, made of hundreds or thousands of atoms, had long been described as landscapes or, sometimes, energy landscapes. The Landscape of String Theory has much less in common with the impoverished landscapes of quantum field theory than with the "configuration space" of large molecules. 1126

With the notion of molecules, we are now using odd metaphors of biology to describe landscapes.

> The mechanisms that underlie the populated Landscape rely only on the principles of general relativity and very conventional applications of quantum mechanics. To understand how the Landscape becomes populated, we will need to examine two very basic physics concepts. The first is metastability of the vacuum. It refers to the fact that the properties of the vacuum can suddenly change with little or no warning. The second concept is that space clones itself. [1127]

The landscape just like an environmental landscape has valleys, mountains, plains, etc. but instead of matter these features would be made up of various vacuum energy levels, both positive, zero, and negative cosmological constants.

Every spot in an expanding universe reproduces itself like cells subdividing. How does space reproduce itself?

> Long ago, when Einstein was still experimenting with the cosmological constant, the Dutch astronomer Willem de Sitter began the study of inflating space. The space or, more accurately, space-time that de Sitter discovered, and which carries his name, is the solution to Einstein's equations when there is no energy or gravitating matter other than the ubiquitous vacuum energy of empty space, i.e., a cosmological constant. Like Einstein, de Sitter assumed the cosmological constant was positive. What he found was an inflating space that grows exponentially with time. Exponential expansion means that in a certain time interval space doubles; then, in the next time interval, it doubles again; and then again. It grows to two times—four times—eight times—sixteen times its original size, in the same way

that compound interest expands money. At a rate of 5 percent interest, your capital would double in fourteen years. The cosmological constant is like the interest rate: the bigger the cosmological constant, the faster the space inflates. Like any expanding space, de Sitter space satisfies Hubble's Law—velocity proportional to distance.

We have used the analogy of an expanding rubber balloon to visualize a growing universe. But de Sitter space is different from the rubber of an exponentially expanding balloon in an important way. In the case of a balloon, the rubber—the fabric of the balloon—becomes increasingly stretched, stressed, and thinned out by the expansion. Eventually it reaches its limits, and the balloon pops. But the fabric of de Sitter space never changes. It is as though the rubber molecules were continually giving birth to new rubber molecules in order to fill the spaces created by the expansion. Think of the rubber molecules as cloning themselves to fill in the gaps. Of course no real rubber molecules are being continuously created. Space itself is reproducing to fill the gaps. One might say that space is cloning itself—each small volume giving birth to offspring, thereby growing exponentially. 1128

So, what does expanding space look like from within the universe and from without the universe?

Suppose an observer in de Sitter space, moving with the general expansion, looked around at her surroundings: what would she see? You might expect that she would see the universe changing with time, getting bigger and bigger. Surprisingly, that's not the case. All around her she would see space flowing away according to Hubble's Law: the close things moving slowly, the distant things moving faster. At some distance the fluid of space would be rushing away so

rapidly that the recessional velocity would become equal to the speed of light. At even farther distances the outgoing points would recede with an even greater velocity! Space in those regions would be flowing away so fast that even light signals, emitted straight toward the observer, would be swept away. Because no signal can travel faster than light, contact with these distant regions is completely cut off. The farthest points that can be observed, i.e., the point where the recessional velocity is the speed of light, is called the horizon, or more properly, the event horizon.

The concept of a cosmic event horizon—an ultimate barrier to our observations or a point of no return—is one of the most fascinating consequences of an accelerating universe. Like the horizon of the earth, it is by no means an end of space. It is merely the end to what we can see. When an object crosses the horizon, it says good-bye forever. Some objects may even have initially formed beyond the horizon. The observer can never have any knowledge of them. But if such objects are permanently beyond the limits of our knowledge, do they matter at all? Is there any reason to include the regions outside the horizon in a scientific theory? Some philosophers would argue that they are metaphysical constructions that have no more business in a scientific theory than the concepts of heaven, hell, and purgatory. Their existence is a sign that the theory has unverifiable and, therefore, unscientific elements to it—or so they say.

The trouble with that view is it does not permit us to appeal to a vast and diverse megaverse of pocket universes, an idea which does have explanatory power: most importantly here, the power to explain the anthropic fine-tuning of our region of space. We will see shortly that all the other pockets are in the mysterious ghostly portions of space out beyond our horizon. 1129

The cosmic microwave background shows us that the rather flat circular shape of the universe may really simply be the horizon where the universe is expanding faster than the speed of light. This is allowable because the speed limit of light is only applicable for the visible universe (limited by the speed of light). The event horizon of a blackhole has a flat circular shape where light cannot escape. We cannot see inside a blackhole because light accelerates faster than the speed of light. While I am writing this, I am sitting in a cruise ship in the middle of the Pacific Ocean with no land in sight with a 360-degree view of the circular horizon boundary. What do I see when I look at the horizon? I see the same shape as an event horizon. Also, as long as I never see any land, I am always in the middle of the event horizon. I have long since wondered how it is that everywhere I look into space, it looks like I am in the middle of a sphere of stars and galaxies. There may be continents and landscapes beyond the horizon but in my view, if I didn't know any better, I would only be informed of my oceanic universe. I could even speculate that a metaphysical God could exist beyond the horizon. Since I had never seen a landscape, I would have no conception of land. I could imbue my need for meaning with a God that would be like a super me or a more perfect me.

But I would only really know a void, a chaos, where dreams may come. How would I comprehend land if it never presented itself to me? Perhaps I may call it landscape. Of course, the Pacific Ocean's horizon is not due to anything concerned with the speed of light but rather with the spherical shape of the earth. However, it does provide an interesting visual analogy to what an event horizon would look like. If entangled particles have wormholes connecting them, could it look like two oceans meeting through pre-spacetime ‘drains’ where water (matter) is never shared between the two of them but entangled wave function exformation is shared in the observer’s byways of branches and roots, rhizomes. The absolutes of

time or space would no longer exist - just information or better exformation with its impending choice that becomes determinate.

Lived Space and Lived Time

> Curiously, in a universe accelerating under the influence of a cosmological constant, the distance to the event horizon never changes. It is fixed by the value of the cosmological constant—the larger the cosmological constant, the smaller the distance to the horizon. The observer lives in an unchanging world of finite radius bounded by her horizon, but in exactly the way that the earth's horizon eludes anyone who tries to approach it, the cosmic horizon of de Sitter space can never be reached. It's always a finite distance away, but when you approach it, there's nothing there! However, if we could get outside the de Sitter space—watch it from a distance, so to speak—we would see the whole space exponentially growing with time. 1130

This expansion of space, growth (*rhizo-phusis*), is not like a balloon getting blown up eventually exploding. Spacetime clones itself in its very expansion. But just as in evolution, cloning is never perfect. Emergence and novelty by the very expansion creates new degrees of freedom, novel new species. In loop quantum gravity we encounter spin foam in zero-point energy. What we think of from classicism as 'reality' is not static but dynamic beyond the most extreme fashion we can imagine. Quantum foam bubbles and gurgles temporality crystalizing into the observer's past into narration, a history, but opened toward emergence. These foam bubbles can join to form larger bubbles creating potential. But there is a fine balance to one's potential. If the bubbles have too much kinetic energy, actual energy, they have the tendency to pop quickly and not make bigger bubbles. If the energy is less vigorous the bubbles tend to make bigger bubbles, clone space. Islands of

new space, new potentials, new universe, are permeated with new potentials. This landscape of growth, of *rhizo-phusis* is not homogeneous on closer inspection. Here is how Susskind describes this process,

> But we've forgotten one thing. The vacuum has the quantum jitters. Just like the thermal jitters of supercooled water, the quantum jitters cause small bubbles to form and disappear. The interior of these bubbles may lie in a neighboring valley, with smaller altitude. This bubbling is constantly going on, but most of the bubbles are too small to grow. The surface tension on the domain walls separating the bubble from the rest of the vacuum squeezes them away. But, as in the supersaturated case, every now and then a bubble forms that is big enough to start growing.
>
> The mathematics describing this bubble formation in an inflating universe has been known for many years. In 1977 Sidney Coleman and Frank De Luccia wrote a paper that was to become a classic. In their paper they calculated the rate at which such bubbles would appear in an inflating universe, and although the rate could be very small—very few bubbles per unit volume—it most certainly is not zero. The calculations used only the most trustworthy, well-tested methods of quantum field theory and are considered by modern physicists to be rock solid. Thus, unless there is something terribly wrong, the inflating vacuum will spin off growing bubbles located in neighboring valleys.
>
> Do bubbles collide, eventually coalescing so that all of space winds up in some new valley? Or does the space between the bubbles expand too quickly to allow the islands to merge? The answer depends on the competition between two rates—the rate of bubble formation and the rate that space reproduces, or the rate of cloning. If the bubbles form very quickly, they will rapidly collide and merge, the whole

space moving to some new point on the Landscape. But if the rate at which space reproduces is greater than the rate at which bubbles form, cloning wins, and the bubbles never catch up with one another. Like the islands of ice in the inflating supercooled lake, the bubbles evolve in isolation, eventually moving beyond one another's horizons. The majority of space continues to eternally inflate.

Which wins, bubble nucleation or space cloning? Generally the answer is not even close. Bubble nucleation, like all other tunneling processes, is rare and improbable. Typically, a very long time will elapse before a bubble large enough to expand accidentally nucleates. On the other hand, the cloning of space, i.e., the exponential growth due to vacuum energy, is extremely rapid if the cosmological constant is not ridiculously small. In all but the most contrived examples, space continues to clone itself exponentially, while islands or bubbles slowly nucleate in neighboring valleys of the Landscape. By a very wide margin, the cloning of space wins the competition.

Let's take a look inside one of the bubbles. What do we find? Typically we will find ourselves located in a valley with altitude somewhat lower than at the start. Space inside the bubble will also be inflating. I'm not speaking about the ordinary growth of the bubble but about the cloning of space inside the bubble. Thus, we start over again. A new patch of space is now located in a new valley. But there are still other, lower valleys. Inside the original bubble, a next-generation bubble may form in another nearby valley with a lower altitude. And if that bubble is bigger than critical size, it begins to grow—a growing bubble inside another bubble.

As a rule, I don't like biological analogies in physics. People tend to take them too literally. I'm going to use one now but please don't get the idea that I think that universes or blackholes or electrons are alive, engage in Darwinian

competition, or have sex.

Think of the megaverse as a colony of organisms that reproduce by cloning. In order to avoid confusion, let me emphasize: the organisms are not living creatures—they are reproducing regions of space. Because clones are identical to their parents, we can think of them as occupying the same valley in the Landscape. We might even think of a Landscape of biological designs: different valleys corresponding to different species. Don't worry about the organisms getting in each other's way. In this fictitious world there is always room for more. When a bubble forms with different properties from the parent, the offspring occupies a new neighboring valley. Because the space inside the bubble also inflates, the offspring begins both the cloning process and the process of inhabiting new valleys by creating next-generation bubbles. In this way the metaphorical colony begins to spread out over the Landscape. The fastest reproducers are the patches of space at the highest altitude where the cosmological constant is largest. In these regions of the Landscape, cloning takes place especially rapidly, and the population of the high altitudes grows fastest. But the high-altitude organisms also feed the lower altitudes so that the population in the nether regions also grows with time. Eventually every niche in the Landscape will become populated, not just once but with an exponentially increasing population. The only thing wrong with the analogy is that real organisms compete and kill each other when their valley becomes overcrowded. No mechanism for competition between pocket universes exists, so the population of every valley continues to increase indefinitely. One might think of these organisms as being totally invisible to one another in every way.

How do bubbles die? If a bubble appears with exactly zero cosmological constant, it will fail to inflate and cease

reproducing. The only such vacuums are the supersymmetric parts of the Landscape. Thus, the supersymmetric region of the Landscape is the graveyard of universes in more than one sense. Ordinary life cannot exist in supersymmetric environments, but more to the point, reproduction of bubbles ceases. 1131

If I live in, am a bubble, which grows as fields of potential I set up a me-verse which I determine and am determined by. Susskind uses the analogy of freezing water to illustrate potential energy.

Water freezes solid at a temperature of 32 degrees Fahrenheit or, what is the same thing, zero degrees on the centigrade scale. However, you can cool very pure water to a lower temperature without its becoming solid if you do it slowly and very carefully. Liquid water below freezing temperature is called supercooled.

Supercooled water, just below the usual freezing temperature, can last for a very long time. But introducing a small bit of ordinary ice will cause the water suddenly to crystallize around it and form a rapidly growing chunk of ice. Just as ice-nine destroyed the world, the real ice chunk will quickly take over the entire body of water.

Putting the ice crystal into the supercooled water is very similar to giving the rolling ball a shove over the nearby hill. It's the event that pushes the system "over the edge." In the case of the rolling ball, the shove has to be strong enough to push it over the barrier. A tiny push won't do it. The ball will just roll back to the starting position. The same is true for the supercooled water. If the ice crystal is smaller than a certain critical size, it will just melt back into the surrounding liquid. For example, an ice crystal just a few molecules in diameter will not grow and take over.

But even without someone adding a chip of ice, the

supercooled water will not last forever. The reason is that the molecules in the liquid are constantly fluctuating, bouncing off one another and rearranging themselves. This motion is due to both the thermal jitters and the quantum jitters. Every once in a while, by accident, a group of molecules will arrange themselves into a small crystal. Most of the time the crystal will be so small that it will quickly melt into its surroundings.

Very rarely, however, a larger crystal will spontaneously form by random accident. Then the crystal will explosively grow, and everything will freeze. The phenomenon is called bubble nucleation, the growing ice crystal being thought of as an expanding bubble. A very similar thing will happen to water that is superheated above the boiling point. The only difference is that a bubble of steam will spontaneously nucleate and grow.

The boundary between the solid ice and the liquid water (or the steam and water) is called a domain wall. It is like a membrane between the two different phases. In fact the domain wall has properties of its own, for example, surface tension that tries to shrink the bubble. Another example of a domain wall is the boundary between ordinary water and air. As a child I was fascinated by the trick of floating a steel sewing needle on the surface of a cup of water. The domain boundary separating air and water is like a skin stretched over the liquid. It has surface tension, which actually has to be pierced in order for an object to penetrate it.

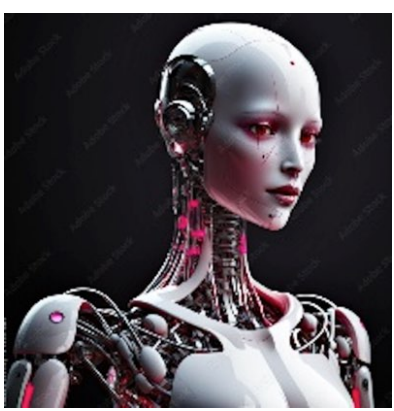
A vacuum with a positive cosmological constant is a lot like a supercooled or superheated liquid. It is metastable and can decay by nucleating bubbles. Every vacuum corresponds to a valley in the Landscape with a particular altitude or energy density. However, although the vacuum may seem quiet and featureless to our coarse senses, quantum fluctuations continually create tiny bubbles of space whose

properties correspond to neighboring valleys. Usually the bubbles quickly shrink and disappear. But if the neighboring valley has lower altitude, then every so often a bubble will appear that is large enough to start growing. Will it take over everything? We will see shortly.

The domain walls that separate a bubble from its environment are two-dimensional surfaces that resemble membranes. These are not the first membranes we have encountered. In chapter 10 we learned about Polchinski's D-branes. In many cases the domain walls are nothing but the membranelike D2-branes. 1132

Islands of potential energy grow throughout the narrative of our lives. Could it be that our potential islands grow into old age? Could death be the most extreme state change of our potential? Could it be that Aristotle was correct about the unmoved mover as pure actuality given by the state reduction of one's potential? Isn't death a radical state change? But there is a symbiotic relationship between actuality and potentiality which Aristotle may have missed (or at least later Latin interpretations of Aristotle's potentiality). Does a lifetime of choice, of actuality, create an island of potential?

ARTIFICIAL INTELLIGENCE AND QUANTUM COMPUTERS



Artificial Intelligence (AI) is the ability of a computer or robot to perform tasks commonly associated with intelligent beings, such as learning, reasoning, problem solving, and using language. AI technology is widely used throughout industry, government, and science. AI is often applied to various domains and tasks, such as medical diagnosis, search engines, voice recognition, and chatbots. The development of AI has been demonstrated that computers can be programmed to carry out very complex tasks—such as discovering proofs for mathematical theorems or playing chess—with great proficiency. However, despite continuing advances in computer processing speed and memory capacity, there are as yet no programs that can fully match human flexibility over wider domains or in tasks requiring large amounts of everyday knowledge. On the other hand, some programs have attained the performance levels of human experts and professionals in performing certain specific tasks, so that artificial intelligence in this limited sense is found in applications as diverse as medical diagnosis, computer search engines, voice or handwriting recognition, and chatbots. 1134

Quantum computing is a field of computing that utilizes the principles of quantum mechanics to perform complex calculations. It is based on the idea of using quantum bits or qubits, which can exist in multiple states simultaneously, unlike classical bits that can only be in one state at a time. This property of qubits allows quantum computers to perform certain calculations exponentially faster than classical computers. Quantum computers are designed to solve problems that are too complex for classical computers to handle. They have the potential to revolutionize fields such as cryptography, drug discovery, and artificial intelligence. However, the current state of quantum computing is largely experimental and impractical, with several obstacles to useful applications. Physically engineering high-quality qubits has proven challenging. If a

physical qubit is not sufficiently isolated from its environment, it suffers from quantum decoherence, introducing noise into calculations. Paradoxically, perfectly isolating qubits is also undesirable because quantum computations typically need to initialize qubits, perform controlled qubit interactions, and measure the resulting quantum states. Each of those operations introduces errors and suffers from noise, and such inaccuracies accumulate. National governments have invested heavily in experimental research that aims to develop scalable qubits with longer coherence times and lower error rates. Two of the most promising technologies are superconductors (which isolate an electrical current by eliminating electrical resistance) and ion traps (which confine a single ion using electromagnetic fields). Quantum computing is a promising field of computing that has the potential to revolutionize many industries. However, there are still many challenges to overcome before quantum computers can be used for practical applications. [1135]

Quantum intelligence is the combination of quantum computing and artificial intelligence. Quantum intelligence can refer to different concepts depending on the context. It can mean the use of quantum computing with machine learning algorithms to achieve computational advantages. Another meaning is the development of decision-making systems that can perform in random and uncertain conditions without massive data. Additionally, it can denote a decentralized and democratic platform to support quantum computing research. Finally, it can imply a hypothetical form of intelligence that deals with quantum information instead of classical information. Quantum intelligence is a term that encompasses a variety of concepts related to quantum computing and decision-making systems. It is a rapidly evolving field with many potential applications in various domains such as cybersecurity, bio-engineering, AI, finance, and complex manufacturing. [1136]

Artificial Intelligence

Artificial intelligence (AI) describes an application or machine that mimics human intelligence. The massive amounts of data that are coming in quickly and from a variety of sources, such as internet-connected devices, sensors, and social platforms. In some cases, using or learning from big data requires AI methods. Big data also can enhance the ability to create new AI applications.

> Big data isn't just big. It is vast, mushrooming, and messy. Too complex for humans or traditional software to analyze, big data is characterized by "three Vs," as identified by IT industry strategist Douglas Laney in 2001: the huge volume of information, the velocity with which it continually amasses, and the variety of formats involved. The development of faster processors, improved computer memory, cloud architectures, and the web of internet connections and online devices have fueled the growth of data.
>
> Computer scientists recognized in the 1990s that some form of machine learning would be needed to analyze and use the huge amounts of data we collect. Today, machine-learning algorithms train themselves, often with human feedback, until they can recognize certain types of information in datasets, isolate signal from noise, detect patterns, and provide insights. The bigger the dataset, the more effective the algorithms become, so big data necessitates and powers machine learning. 1137

Chatbots is an AI system that mimics human conversation. While some simple chatbots rely on pre-programmed text, more sophisticated systems, trained on large data sets, are able to convincingly replicate human interaction. Machine learning describes a subset of artificial intelligence.

> This term arose in the 1970s. Machine learning is distinguished by a machine or program that is fed and trained on existing data and then is able to find patterns, make predictions, or perform tasks when it encounters data it has never seen before. 1138

A subset of machine learning is called deep learning. Deep learning uses machine learning algorithms but structures the algorithms in layers to create "artificial neural networks." These networks are modeled after the human brain and are most likely to provide the experience of interacting with a real human. An approach that includes human feedback and oversight in machine learning systems. Including humans in the loop may improve accuracy and guard against bias and unintended outcomes of AI. A computer model is a computer-generated simplification of something that exists in the real world, such as climate change, disease spread, or earthquakes. Machine learning systems develop models by analyzing patterns in large data sets. Models can be used to simulate natural processes and make predictions. An important part of machine learning is focused on giving computer algorithms or software routines the ability to learn and alter their own code to accurately perform different kinds of tasks and connections outside of its original programming. Another area of concern in this regard is called ‘singularity’ which refers to how and if it would be possible for artificial intelligence to evolve to a point where humans would no longer be able to control it. Another big part of AI is dependent on interfacing with humans without relying on conventional computer peripherals like keyboards, a mouse, a monitor, and even conventional webcams. The idea is that interaction with the web will be like a real-world interaction like we engage in every day. Interconnected sets of processing units, or nodes, modeled on the human brain, which are used in deep learning to identify patterns in data and, on the basis of those patterns, make predictions in response to new data. Neural networks are used in facial

recognition systems, digital marketing, and other applications. 1139

Artificial Intelligence (AI) is a vast field with diverse research areas. Here are some key areas of active research and development:

- **Quantum Computing:** Exploring how quantum mechanics can enhance computation and solve complex problems.
- **Healthcare:** Applying AI to medical diagnosis, drug discovery, personalized treatment, and health monitoring.
- **Autonomous Vehicles:** Developing self-driving cars and other autonomous transportation systems.
- **Internet of Things (IoT):** Integrating AI with connected devices for smart homes, cities, and industries.
- **Robotics:** Enhancing robot capabilities for tasks like manufacturing, exploration, and assistance.
- **Expert Systems:** Creating intelligent systems that mimic human expertise in specific domains.
- **Natural Language Processing (NLP):** Enabling machines to understand and generate human language.
- **Neural Networks:** Investigating deep learning models inspired by the human brain.
- **Pattern Recognition and Matching:** Identifying patterns in data for applications like image recognition.
- **Computer Vision:** Enhancing machines' ability to interpret visual information.
- **Virtual or Augmented Reality:** Integrating AI into immersive experiences.
- **Bio-Robotics and Informatics:** Combining biology, robotics, and AI for medical and biological research.
- **Intelligent Control Systems:** Designing AI-based controllers for complex processes.
- **Cybersecurity:** Developing AI solutions to protect against cyber threats. 1140

These areas intersect and drive innovation, shaping the future of AI in various fields. 1141 There is no doubt that the future of AI will dramatically change the world. AI will provide opportunities for advancement that will vastly exceed what humanity has achieved up to now. But AI also presents a threat like no other we have seen in history. It can and will be used to exploit human weaknesses for exploitation, totalitarian atrocities, and make our current marketing science look like the dark ages. The only defense against this will be critical thinking on the part of individuals in mass. This requires a much more concerted effort than our history of Enlightenment was ever able to achieve. It also requires an ethics that goes beyond what our religious histories have been able to achieve. This is a major theme in this book. I will discuss this extremely different approach to ethics later.

Quantum Computers

The *phusis* of quantum computers '*is*' the *phusis* behind our abstract reductions and binary dualities arising from our classical histories of physics and philosophy. But *phusis* underlies these abstractions including biology. Molecular physics is becoming increasingly more relevant. Our brains '*are*' quantum computers which evolution devised over millions of years. This means the same problems which affect quantum computers are fundamentally the same problems which affect us, our historic narratives, our basic notions of Being and existence. The inability to complete ourselves in ourselves, our metaphysics and physics go much deeper than the truths or falsities of our histories, the objectivities of our subjectivities. If we truly want to understand who we are and what we are not, we need to look at the spookiness of *phusis* and quantum computing is a great place to start. Keep this in mind as we explore quantum computing but for now, what are the problems with quantum computing?

- Qubits can interfere with themselves. Interfering qubit states work like two different waves in the ocean coming together. Depending on how they combine their amplitudes may add or subtract to the resulting wave amplitude. Adding amplitudes are called constructive interference and subtracting amplitudes are called destructive interference. In any case, this can change the qubit value.
- Entangled qubit systems correlate with each other to form a single entangled system. Even if the qubits were infinitely far apart, we can both set, observe, or measure the systems coherently, as a single system. The amount of coherence is reflected in probabilities. But the entangled qubit system doesn't know that it is supposed to stay isolated from the universe of entangled systems. These entangled elementary particles do not see an 'inside' as opposed to an 'outside' like the enclosure of a quantum computer. It sees the quantum universe where these kinds of macro-level 'things' do not exist. Keeping the 'things' from entangling with the quantum computer as much as possible takes an incredible amount of care. [1142]

The biggest problem with qubits is also their greatest asset. Anything and everything interact with them. Therefore, if you want to be able to use them to compute data you must isolate them so other phenomena does not alter them. Even then, because they can never be fully isolated, error correction techniques and other strategies must be used to retain their computational integrity.

What makes a good quantum computer (gate operations will be discussed a little further down)?

Its qubits stay coherent for long periods of time. We can only leverage the quantum mechanical properties of qubits whilst they are coherent. This is when their state is still in

Superposition – i.e. hasn't collapsed to zero or one which is known as decoherence. Decoherence is caused by the qubit interacting with the outside world, and explains why much of today's quantum computers are large engineering feats – much of the work goes into keeping qubits isolated from the outside world.

Its qubits are highly connected. This generally refers to different particles having correlated quantum states, known as Entanglement. This allows operations to act on multiple qubits and increases the information density of a quantum computer.

Note: there's a conflict between trying to keep qubits isolated from the outside world while ensuring their connectivity.

It achieves quick gate operations: The desire for a quantum computer to demonstrate quick gate operations should be non-controversial. This metric should be considered in the context of gate fidelity and qubit coherence. Speedy gate operations are only helpful if information is appropriately preserved.

Note: To get a feel for how these factors interact with each other you can observe that Superconducting implementations have shorter qubit lifetimes but faster gate operations than Ion Traps.

Operations achieve high gate fidelity. Classical computers use electrical signals that represent bits that are zero or one. If the signal experiences noise (e.g. from heat) and the signal doesn't represent precisely zero (for the sake of argument let's say 0.0004), then it's easy to attenuate the noise so that 0.0004 is treated as zero. Qubits need to precisely represent numbers (or more strictly amplitudes!) that are not just zero and one, so it is not possible to attenuate noise in such a way. The more logic gates you add to a quantum computer, the more noise builds up (which by

definition cannot be attenuated). Therefore a good quantum computer demonstrates high gate fidelity where information is precisely preserved between operations.

High degree of scalability. We have left this until last to highlight that much of the factors above pertain to the inherent "noise" that must be grappled with in quantum computing systems. Quantum Computers will only be useful if we can achieve high gate fidelity and connectivity. Much research is going into understanding how to reduce noise through error correction. Once we have worked out how to build noise-free qubits (known as logical qubits) a key focus of further development will simply be on how we can scale up quantum computers to include more qubits (whilst preserving connectivity and minimising noise).[1143]

In the same way we were an extreme, practical, evolution from quantum physics, quantum computing is a sped-up evolution, into the foreboding world of quantum physics. Whether we like it or not, quantum computing will make a major difference in humanity's future. But this comes with extreme advantages and disadvantages. If we can survive violent, reactionary tendencies from unrelenting power structures in historic societies, it will only be because commonsense has been able to come to terms with the abyss we face and how that affects our relations with others. The certainties and origins of classicism have failed miserably to live up to its narratives. Namely, our own classically styled history of the rule and authority of origin fashioned as essence and Being.

Quantum complexity has resulted in a new kind of mathematics called "complexity theory" which will be discussed later. Quantum complexity allows quantum computing capacity to scale up much faster than normal computers. Quantum computing complexity gives it the ability to scale up exponentially not simply additive as classical computers. As long as quantum computing systems remain entangled, the systems can be distributed all around the earth and

information can be processed very quickly and instantly retrieved depending on the more traditional computational interfaces which translate information to and from our well-established historic infrastructures and technologies. Of course, the mechanisms that translate, encode and decode information may take a small amount of time. However, the actual process of exformation transfer is instantaneous as it is pre-spacetime. There is no 'mechanism' between the exformation of entangled systems. There is no wire or cable. We may call the medium of an entangled particle a micro 'wormhole' or more properly Einstein-Rosen bridge.[1144] There is nothing between two entangled systems, not time or space but there is 'information' albeit useful but with strangely different meanings of the word - what I refer to as exformation.[1145] This new kind of information is not like digital information at all. Exformation functions like our brain with the mechanism of quantum molecular biology translating or better transforming into all our practicalities. Exformation does not have to be a zero or one, Being or nonbeing, existence or nonexistence, self or other, and all the other binary dualisms we hold sacred. Exformation can also be more or less certain. It can also contain a whole lot more information, potentialities which can *become* actualities, than digital computers.

The concrete and practical use of quantum computing is not something which can merely be thought of as a new technology among a long succession of technological improvements. There is a gaping difference in quantum computing technology from what classicism refers to as thinking, as knowledge. While some are occupied with looking for alien life in the universe, we need to come to grips with the fact that we are at the very beginning of creating alien life. The brain or, better, mind as an entangling and entangled system may continuously be cohering and decohering eerily similar to the underlying technology of quantum computing. We know that the history of science fiction has had an uncanny success intuiting real changes in science and technology. In the case of quantum computing, there is a real possibility that quantum

physics is at the infant beginning of creating a thinking being. This thinking being could not, or better should not, be distinguished from us with regard to consciousness and self-reflection. There is a budding field of study called quantum mind which I will not get into because I do not think it is appropriate for this book.[1146]

Quantum computing is an Everett styled informational branch which is tightly controlled to retain its *telos* and origin, what we think as its culmination or final end in the simple phrase – 'practical purpose' and what Aristotle called actuality. However, Everettian information is fundamentally relational, more verb than noun. Information is the usual way we think it is means 'making sense', compelling *phusis* to conform to classically derived notions of cause and effect as opposed to more ancient narratives such as,

- ancient shamanistic practices migrating into alchemical practices,
- Greek *theos* meaning god or goddess, ruler title as Zeus, from Proto-Indo-European *$d^{h}éh_{1}s$, from *$d^{h}eh_{1}$- ("to do, to put, to place"), [1147] what modernity translates as the notion of practicality,
- Latin *deus* translated in Classical and Ecclesiastical Latin as god or deity and in the later Roman Christian tradition as God. In Classical Latin it could be feminine, goddess. Latin deus and dīvus ("divine") are in turn descended from Proto-Indo-European *deiwos, "celestial" or "shining", from the same root as *Dyēus, the reconstructed chief god of the Proto-Indo-European pantheon. [1148]

Classically, information can be demonstrated in our modern use of the term 'science'. Classical science is where information is determined from successions of cause and effect to be what shows phenomena in the mode of truth, as correctness, as predictive and conforming more truly to experimentation and the scientific

method. The truth of cause and effect and the truth of the cosmos which sustains and maintains classic physics is precisely what is becoming inadequate in quantum physics. Even more, the ready-made expectation of forthcoming answers has found no easy words to articulate what a new 'truth' from the classic mold would look like. This inadequacy which philosophy terms 'inability to be able' marks an existential moment where truth becomes inadequate, and demand is put on us from we know not where. Our history fails us. Our language, our thoughts languish in silence.

When truth itself becomes a theme, philosophy turns to epistemology which questions how we can know that truth is really true, how we know that we know. Epistemology is the quest for certainty. Classical information and how we arrive at our sense of self are rooted in assumptions we simply think of as common sense. The Western history of epistemology and its modern progeny common sense cannot give us an account of any such thing as 'reality' in the abyssal face of quantum entanglement. This 'inability to be able' characteristically marks an epochal change wherein necessity must evoke a new history that cannot be summed up by the history of Being. Here, a new history is not a renewal but a yawning gap. The knee-jerk reaction is to go back to what no longer works.

Phantasm, going back to a socio-political narrative which never was, reactionism, can only end in war, societal self-destruction. This is a sociological existential crisis. In our case, the only way for survival of our species and our planet is for each of us to look deeply into the abyss which faces us. What faces us cannot yet 'have been thought'. By 'not yet have been thought' we indict thinking and history *itself*. For hints of what cannot yet 'have been thought' we need to look at fundamental historic inadequacies posed by quantum entanglement. These inadequacies began early on in intuitions of ancient histories which questioned origin and were subsequently overtaken as the dawning of our epoch of Being which impels us to follow its 'logocentric' informational branch, its

metaphysics of *ratiō*, *logica*. taken into Being, existence, cause and effect. But now in quantum physics and quantum computing *logos* harkens back to ancient voices and simultaneously propels us reluctantly away from the force and violence which authorized its origin. The abyss which stares back at us is not Nietzsche's eternal recurrence of the same but the face of radical alterity which gazes back upon us.

First Look at Quantum Computing

Here are just a few of the companies developing quantum computers:[1149] I will have a more complete list of companies developing quantum technologies a little later.

- Amazon.
- D-Wave Systems
- Google
- IBM
- IonQ
- Microsoft
- QCI
- Quantinuum

IBM, a leader in quantum computing tells us one huge advantage in processing time,

Quantum computing's potential for significant speedup over classical computers, according to IBM internal analysis

Type of scaling	Time to solve problem				
Classical algorithm with exponential runtime	10 secs	2 mins	330 years	3300 years	Age of the universe
Quantum algorithm with polynomial runtime	1 min	2 mins	10 mins	11 mins	~24 mins

Quantum computers are already optimizing routes of thousands of fuel tankers around the world. Helping determine which Intensive Care Unit patients need the most urgent care. They are already mimicking chemical processes at the atomic level to find ways to make better materials. They will supercharge artificial intelligence, make driverless cars and taxis run seamlessly,[1151] and make weather prediction much more accurate.[1152]

Quantum computing uses multidimensional processing which takes much more processing power than standard binary computers. Quantum computers 'think' like we model atoms and multidimensional physics. The highest level of quantum computing called universal quantum computing will eventually work much better with artificial intelligence because it can work on multiple solutions at once, like conscious and unconscious, and it does not have to process every possible solution explicitly to come up with the best solution like traditional computers. Quantum computers learn and make decisions much more efficiently with big data sets. Quantum computers will be much better at financial modeling. Quantum computers will have encryption and decryption schemes that will be unbreakable. Quantum computers will handle real time data like traffic route planning, weather patterns, and fleet delivery efficiency. Quantum computers will do research, development, manufacturing, and prototype design much faster with less mistakes and less testing. Quantum computers will quickly develop medical and pharmaceutical drugs solving problems like cancer and viruses which would otherwise take years. Quantum computers will help us develop much better batteries using many kinds of materials.[1153] Quantum computers along with advances in artificial intelligence have the capacity to become self-conscious! Why? Because quantum computers utilize the same physics as our brains!

A normal computer has memory and something which saves data to the memory and recalls it. Because 'quanta' in quantum

mechanics means a discrete, stable number of states and not an infinite number of states, quantum computers can leave the realm of pure potentiality and become actual. A quantum computer is better thought of as entangled systems. A maximally entangled qubit can only be entangled with two qubits. This is called entangled monogamy. However, any number of qubits can be entangled. If two qubits are entangled the probability of collapsing from superposition into one of two states is maximally reduced to 1/2. As more than two qubits are entangled, like a tripartite of three qubits, the probability of collapsing into one value would be 1/3. When we read the value of one qubit entangled with another qubit, we are effectively writing information into the other qubit. However, if we try to read the value of the qubit we originally wrote again, we effectively destroy the entangled state of the other qubit. As I will mention a little later, this functions biologically like neural brain cells. Why is this?

If two qubits were in perfect isolation from their environment, they would maintain coherence indefinitely. But to keep them perfectly isolated from their environment, we would have to not read them again. When we read them again, the environment is no longer perfectly isolated due to the intervention of the subsequent read and the entangled qubits decohere. On a larger scale when particles become entangled in nature, the initial entangled particles begin to start entangling with other particles in the environment sharing information coherently. Think analogously about this as a virus spreading by replicating itself exponentially. Physicists have found that once this chain of entanglement begins spreading, an occasional measurement might destroy some of the entangled particles, but the chain of entangled particles will keep spreading preserving the initial information. The coherent system acts as a single ‘organism’ preserving informational integrity. However, too much measuring will slow down and stop the entangled organism from spreading and the information will be lost to decoherence. This is analogous to injecting an anti-virus drug into an organism

defeating its replication. 1154 From what I have already discussed, this is the potential informational branching of the wave function into actuality. The problem with this analogy is that it obscures on a deeper level what is really occurring.

Decoherence is not the loss of information or the end of the replicating of the virus, it is the branching of informational pathways into another temporal pathway which we no longer have access to. Coherence did not 'stop', it just left our temporal pathway of observation. 1155 Think of this as the cat in the box and how each subsequent observer or observation branches off from a unitary, 'coherent' (or metaphysical) temporality. The irreversible branch of information for each observer is not recoverable into a synthesis, a rational logic, with common origin. In philosophy we might call this chaos. In quantum computing we call this noise, but it is really exformation that we can no longer access. If we want to make a quantum computer a practical reality, we need to find ways to follow our temporal branch force of *phusis*, the practical task we want to accomplish.

In order to make a quantum computer perform practical tasks, we need to severely reduce environmental impact or informational branching updates which are lost to us. We need to make sure that when we read a quantum state, we previously wrote from the measurement process, we do not destroy, or reinitialize back into superposition an informational branch we no longer have knowledge of or access to. There are multiple ways of doing this I will discuss but for now several ways can be deduced from what was just written:

- Isolate environmental susceptibility to other branches of information.
- Error correction or redundant pathways which allow us to retain and restore the original information.
- Allow qubits to replicate and only measure occasionally.
- Statistical correlation, redundant measurements, which

do not allow too many observational disturbances.
- Use traditional computers to help us retain and access information. 1156

The applications for quantum computing go beyond algorithm speedup and solving problems we thought were practically unsolvable but also for encryption and decryption which could never be broken by any kind of external intervention into its own informational-world branch. There are many other applications which I will discuss a little later.

The logic of "it from bit"

John Wheeler (1911 - 2008) was one of America's most prominent theoretical physicists. He worked with many of the most important quantum physicists of the 20th century including Einstein. An article in Scientific American 1157 tells us the John Wheeler was one of the first and most prominent physicists to propose that 'reality' may not be wholly physical. Let this sink in. Wheeler is not some kind of spiritualist. Wheeler goes down in history as one of only a few elite physicists. He was highly schooled in classical science not metaphysics. To add insult to injury he even goes on to suggest that our cosmos must be a participatory phenomenon requiring the participatory act of observation. If he were Catholic, he would have been excommunicated right then and there. Wheeler was also one of the first to find interesting links between physics and information theory. This went all the way back to the famous mathematician Claude Shannon. In writing of this, Wheeler was almost prophetic in the direction physics and math would soon embark on in earnest. Similarities have been drawn between physics' participatory elementary particle – the quantum, and information theory's binary unit, the 'bit', representing two choices – yes or no, zero and one. The article goes on to tell us that before the physicist *chooses how* to observe there is neither wave nor particle. It is not real or ideal. It is

not even an *it*. The most we can think is that *it is* indeterminate – it is metaphorical limbo. We have to ask the question for ***it*** to be. Currently, there are quantum philosophers who are making valiant efforts to find a novel home for this in epistemology and ontology but as we saw in the section "Philosophical Questions Posed by Entanglement" it seems like we may still be in the phase of 'How many angels can dance on the head of a pin?' Wheeler tells us, "Not until you start asking a question, do you get something." And "The situation cannot declare itself until you've asked your question. But the asking of one question prevents and excludes the asking of another." Could this be what the Zen master meant by a Koan? However, we are not thinking here of metaphysics or Buddhism. This is Western style physics, and this is one of history's most prominent physicists.

Information gives us patterns and relationships. Wheeler tells us that a certain kind of information is the genesis of 'reality' and the notion of 'things'. Wheeler famously coined the phrase 'it from bit' to describe this type of information.

> In 1990 the distinguished theoretical physicist John Wheeler coined the phrase "it from bit" to encapsulate a radical new view of the universe that he had been developing over the preceding 20 years:
>
> "It from bit symbolizes the idea that every item of the physical world has at bottom…an immaterial source and explanation; that which we call reality arises in the last analysis from the posing of yes-or-no questions and the registering of equipment-evoked responses; in short, that all things physical are information-theoretic in origin."
>
> In other words, what Wheeler proposed is that at the most fundamental level, all of physics has a description that can be articulated in terms of information. While Wheeler's scientific career ran from early work with Niels Bohr on nuclear fission in the 1930s to quantum electrodynamics,

> general relativity and the foundations of quantum mechanics, this radical idea received little support at the time. However, in hindsight, we can now see that it was truly visionary.[1158]

It is highly interesting that complexities which pass into quantum chaos allow us to ask yes or no questions of it. Quantum physics has rightly deserved its reputation of being cryptic to the uninitiated. Quantum physics has the capacity to be both one and the same as the finitude of particle and the infinitude of wave. Information can be quite trite as yes or no and quite spooky as exformation. Earlier I made a huge distinction between the typical kind of classical information which assumes cause and effect and highly entangled information I called exformation. In philosophy cause and effect and existence are inextricably linked in the philosophical history called ontology - the study of being or what 'is'. In more recent times philosophers are struggling with reconciling classical ontology and exformation.

Complex information theory, which is well on its way in quantum computing, presents very difficult problems to ontologists. This difficult problem tends to get glossed over when the term information is used generically. The problem here is that exformation then gets taken as necessarily ontological, as fundamentally existent in spacetime. Typically, this turn in ontology relies on some modified understanding of Einstein's failed notion of locality where locality loses its sense of nearness in order to give an account of exformation. However, causation is still retained by these new ontologists as jettisoning causation would spook the history of ontology. Therefore, as discussed previously, they have resorted to ideas of retrocausality and perhaps some sort of faster-than-light negotiation process which has its own problems. Nevertheless, ontologists are not the only ones struggling with exformation which seems to defy spacetime with regard to classical notions of causation. While these philosophical issues still linger, Wheeler was able to circumvent them by observing that we did not

need to understand the excess of the spookiness of exformation for certain kinds of tasks. Why? Because we can simply ask the void questions, and it obliges us by giving us yes or no responses to our questions.

> Wheeler has condensed these ideas into a phrase that resembles a Zen koan: “the it from bit.” In one of his free-form essays, Wheeler unpacked the phrase as follows: “...every it--every particle, every field of force, even the spacetime continuum itself--derives its function, its meaning, its very existence entirely--even if in some contexts indirectly--from the apparatus-elicited answers to yes-or-no questions, binary choices, bits.”[1159]

Could this be why classicism worked? Because yes and no questions are a limited case of the spooky. Wheeler’s “it from bit” is the qubit of quantum computing. Qubits ‘think’ like our everyday practical brain works. Qubits have even sparked a lot of research into brain neuroscience. Brain neurons are composed of quantum entangled particles just as any other quantum system, so it is no wonder that there are similar processes working in our brain as we see in qubits.

Just an observation here, in my estimation the real possibility of androids which think like us or probably better than us is made possible by quantum computing and qubits. In Isaac Asimov’s science fiction book “I, Robot” he gives the robot three laws:

First Law

A robot may not injure a human being or, through inaction, allow a human being to come to harm.

Second Law

A robot must obey the orders given it by human beings except where such orders would conflict with the First Law.

Third Law

A robot must protect its own existence as long as such protection

does not conflict with the First or Second Law.

This did not work so well for humans. Let's hope the androids will not get any ideas from old Schwarzenegger movies. Since science fiction has a way of becoming true, we better watch out… they may decide they do not like us because we are inefficient slobs who, like Charlie Brown's Pig Pen, make a cloud of trash everywhere we go.

The quantum computing world calls our current binary computers classical. Classical computers are always fully determined by the state of their bits. One classical bit can only have two states or values, 0 and 1. A quantum bit or qubit can also be 0 or 1 or a proportion of both states 0 and 1 in superposition which practically can result in a probability of being a zero and a probability of being a 1 upon measurement or observation.

> While a bit, or binary digit, can have a value either 0 or 1, a qubit can have a value that is either 0 or 1 or a quantum superposition of 0 and 1.[1160]

Depending on the proportions of 0 or 1 there is a probability of being 0 or a probability of being 1.

> **Qubits are represented by a superposition of multiple possible states**
>
> A qubit uses the quantum mechanical phenomena of superposition to achieve a linear combination of two states. A classical binary bit can only represent a single binary value, such as 0 or 1, meaning that it can only be in one of two possible states. A qubit, however, can represent a 0, a 1, or any proportion of 0 and 1 in superposition of both states, with a certain probability of being a 0 and a certain probability of being a 1.
>
> **Superposition gives quantum computers superior computing power**

> Superposition allows quantum algorithms to process information in a fraction of the time it would take even the fastest classical systems to solve certain problems.
>
> The amount of information a qubit system can represent grows exponentially. Information that 500 qubits can easily represent would not be possible with even more than 2^{500} classical bits.
>
> It would take a classical computer millions of years to find the prime factors of a 2,048-bit number. Qubits could perform the calculation in just minutes. 1161

Quantum computing is a bold, practical step into the foreboding world of quantum physics. Whether we like it or not, quantum computing will make a huge difference in humanity's future if we can survive the onslaught of violent reactionary and conservative tendencies from unrelenting power structures in society. Quantum complexity has resulted in a new kind of mathematics called "complexity theory." First, let's take a look at some logical methods for quantum computing by looking at classic logic, fuzzy logic, and quantum logic.

Classical Logic

Classic logic is a logic which includes basic laws of identity forming the basis of epistemological designations such as truth and falsity, A = A (A equal A is true, also called a tautology in philosophy) and A = !A (A is equal to not-A is false) and hypothetical equality relations such as, if A = B and B = C then A = C. Classic logic has an either-or quality to it. Our current computers use classic logic operations.

> Traditional logic theory, sometimes called 'crisp logic,' uses three logic operations--AND, OR and NOT--and returns either a 0 or 1.1162

AND operations are:

• 1 AND 1 = 1 (True)

• 1 AND 0 = 0 (False)

• 0 AND 1 = 0 (False)

• 0 AND 0 = 0 (False)

This operation works the same way for more than two variables.

OR operations are:

• 1 OR 1 = 1 (True)

• 1 OR 0 = 1 (True)

• 0 OR 1 = 1 (True)

• 0 OR 0 = 0 (False)

The **NOT operation** simply flips a bit: 0 becomes 1 (False to True) or 1 becomes 0 (True to False).

Other logical operations include:

• **'Exclusive OR' (XOR):** True only if the inputs are different.

◦ 1 XOR 1 = 0 (False)

◦ 1 XOR 0 = 1 (True)

◦ 0 XOR 1 = 1 (True)

◦ 0 XOR 0 = 0 (False)

• **'NOT AND' (NAND):** The inverse of AND; False only if both inputs are 1.

◦ 1 NAND 1 = 0 (False)

◦ 1 NAND 0 = 1 (True)

◦ 0 NAND 1 = 1 (True)

◦ 0 NAND 0 = 1 (True)

• **'NOT OR' (NOR):** The inverse of OR; True only if both inputs are 0.

◦ 1 NOR 1 = 0 (False)

◦ 1 NOR 0 = 0 (False)

◦ 0 NOR 1 = 0 (False)

◦ 0 NOR 0 = 1 (True)

• **'Exclusive NOT OR' (XNOR):** True only if inputs are the same state.[2]

◦ 1 XNOR 1 = 1 (True)

- 1 XNOR 0 = 0 (False)
- 0 XNOR 1 = 0 (False)
- 0 XNOR 0 = 1 (True)

There are many other kinds of classical logic operations. These operations are the basis of all the problems classical computing can solve. These logic operations work the same way for more than two variables.

What can AND, OR, and NOT operations do?

> A surprising fact is that all possible processes, from simple addition on a calculator to browsing Facebook, can be constructed from a small set of these gates called a 'universal gate set'. In other words, you should be able to run any possible algorithm using a universal computer — an observation first made in 1936 by Alan Turing. [1163]

When a classical computer has to do something like multiplication it has to use many of these simple gates to arrive at real number solutions.

Fuzzy Logic

Fuzzy logic is a logic which fundamentally deals with uncertainties. It is really a generalization of classical logic with probabilities assigned to it. It is not really used in artificial intelligence but more in consumer applications for low level machine operations like trying to determine when a filter is dirty enough to need replacing.

> In the 1980s fuzzy control became a huge industry in Japan and other countries where it was integrated into home appliances such as vacuum cleaners, microwave ovens and video cameras. Such appliances could adapt automatically to different conditions; for instance, a vacuum cleaner would apply more suction to an especially dirty area. One of the

benefits of fuzzy control is that it can be easily implemented on a standard computer.[1164]

Fuzzy logic has the elements of classic logic with an additional component. Fuzzy logic makes the logic of identity into degrees of uncertainties. This is more like probabilities in classical science. One way probabilities arise in classical science is due to infinities, highly complex phenomenon, which necessarily imply classical chaos theory and initial starting conditions which get infinitely more nuanced and correspondingly increasingly more accurate – the butterfly effect. In this sense identity can be maintained as a movement towards infinity which we can never arrive at (except perhaps in Hegel's dialectics…not). Another way to think this is that fuzzy logic makes classic logic a special case of uncertainty where identity can only be actualized in degrees of certainty.

"Fuzzy logic is a generalization of standard logic, in which a concept can possess a degree of truth anywhere between 0.0 and 1.0. Standard logic applies only to concepts that are completely true (having degree of truth 1.0) or completely false (having degree of truth 0.0). Fuzzy logic is supposed to be used for reasoning about inherently vague concepts, such as 'tallness.' For example, we might say that 'President Clinton is tall,' with degree of truth of 0.9."

"Fuzzy logic is a technique for representing and manipulating uncertain information. In the more traditional propositional logic, each fact or proposition, such as 'it will rain tomorrow,' must be either true or false. Yet much of the information that people use about the world involves some degree of uncertainty. Like probability theory, fuzzy logic attaches numeric values between 0 and 1 to each proposition in order to represent uncertainty. But whereas probability theory measures how likely the proposition is to be correct, fuzzy logic measures the degree to which the proposition is

correct. For example, the proposition 'President Clinton is young' may have a degree of correctness 0.8."

"The important distinction between probabilistic information and fuzzy logic is that there is no uncertainty about the age of the president but rather about the degree to which he matches the category 'young.' Many terms, such as 'tall,' 'rich,' 'famous' or 'dark,' are valid only to a certain degree when applied to a particular individual or situation. Fuzzy logic tries to measure that degree and to allow computers to manipulate such information." 1165

For standard real numbers all linear operations are continuous. This means a function like 5.0 times n, where n are numbers ranging from 1.0 to 10.0 will always have another real number result.

In fuzzy logic, usually, we only consider logical operations which are continuous functions of their inputs. This makes sense because the degree of uncertainty are only approximately know, and for operations to be meaningful, we need to require that similar values of the input degrees lead to similar values of the result of the logical operation.1166

Fuzzy logic is used in fuzzy set theory where, in the previous comments, A and B are sets of related members such as the set of all adults and the set of all children and the set of fuzzy middles. Fuzzy middles would be the set of all probabilities under certain conditions in which the members could be considered children or adults. Fuzzy logic has the capacity to make decisions based on the natural and pragmatic way in which we make decisions. Let's note that here we already see a fundamental fissure between the idealized, absolute assumptions of our ideas of reality and day to day ways we phenomenologically utilize uncertainties or conversely

probabilities, in making judgements.

Quantum Logic

Quantum logic has some similarities to fuzzy logic.

> Both quantum logic and fuzzy logic describe uncertainty: [1167]

However, with regard to fuzzy logic, quantum logic disputes the 'is', the absolute certainties of our reasoning, our metaphysics, our dialectical actualities which must inevitably get taken up by absolute Concept as potentialities.

> • quantum logic describes uncertainties of the real world (to be more precise, the uncertainty of our best theory of the world), while
>
> • fuzzy logic describes the uncertainty of our reasoning. [1168]

In classic logic !!A = A or the 'NOT' of a 'NOT' operation is the original term. In fuzzy logic the 'not' of 'not' of A has a probability of being A from 0 to 1. There is an excess to the NOT, negation, in quantum logic. This is another essential operator in quantum logic. There is no such thing as a square root of the 'not' in either classic or fuzzy logic. The square root of 'not' makes no sense in either classic or fuzzy logic.

> It is known that, in contrast to quantum logic, in fuzzy logic, if we restrict ourselves to continuous operations…there is no square root of negation[1169]

However, the square root of 'NOT' makes sense in quantum logic. The easiest way to look at this operator is to think about two whole, discontinuous bodies of information which have no apparent

causal relation with each other. So, the square root of 'NOT' here indicates the 'not yet physical' which cannot *be* unified apart from spooky observation, observation which does not gleam 'reality' or its NOT but an excess to both. Again, this is not from a current lack of knowledge that will one day be bridged when we know more. We know now that no underlying metaphysics of reality will finally explain these radical exteriorities. We can only get indications as probabilities and uncertainties based on the strange observe effect of experimental 'observations' 1170 - spooky branching informational updates which never precludes diverging actualities as if they dissipate into nothingness or 'pure potentialities but actualize as inaccessible branches of information forever lost to us. 'Observations' are abbreviated in quantum wave functions as superposition. In quantum logic there is an unbridgeable rupture in logic where absolute discontinuities from one observed state to another state imply the complementarity principle. To illustrate this, let's think in general of the superposition statement which composes the quantum wave function and complexity theory, values, functions, where the square root of minus one makes 'sense'. Please bear with me on this next description of superposition starting with a discussion of how mathematics describes superposition with complex numbers.

Superposition and Qubits

Let's just look at the simplest case, complex numbers. The wave function is a combination of complex values and functions made up of real numbers and imaginary numbers.

> Do complex numbers really exist? Is this a trick question? How can we possibly see the square root of a negative number and, by the definition of a square root, claim that such a number can be affirmed? Other than for the sake of representation, this question was not easily answered until

around three hundred years ago. Whether or not these numbers make sense in our reality, they are nevertheless quantities that arise in abundance from study within the discipline of mathematics. [1171]

Imaginary numbers had their begrudging start in the mid-1500s.

For thousands of years, early mathematics flourished with little worry about the limitations of only positive and real quantities. The initial discovery of imaginary numbers in the mid-1500s was everything but an Archimedean "Eureka" moment. Mathematicians circled around similar ideas regarding complex numbers for decades. Early mathematicians had no concept of negative numbers, let alone imaginary ones. However, mathematicians that studied solutions to different cubic equations noticed something profound - quantities that weren't "possible." The fact that the concept was so unfamiliar made them believe that they had discovered different things, though. Essentially, mathematicians worked amidst a kind of "language barrier." Therefore, conflict became prevalent throughout these years. With no standard by which to evaluate their thinking, each mathematician was more or less building from the ground up. As a result, there was little progress in complex theory for many years. However, the delayed consensus that was achieved - the certain existence of a complex system - strengthened mathematical studies in areas like roots of functions, the Cartesian coordinate system, and intermediate algebraic equations.

Over the span of four centuries, the complex system was studied with increasing intensity as it became more widely accepted as mathematical truth, whether at first for representation's sake or later by choice. [1172]

Real numbers are the numbers we all love to hate. Let's call this [a]. A complex number is any number multiplied by an imaginary number. The definition of an imaginary number is the square root of -1. Let's call this [i]. Of course, the square root of -1 is an absurdity or better, it does not exist. For any wave function description of superposition there is the real part [a] and there is an imaginary part [i]. If you are wondering what the heck imaginary numbers are, you are not alone.

> Imaginary numbers are what you get when you take the square root of a negative number, and they have long been used in the most important equations of quantum mechanics, the branch of physics that describes the world of the very small. When you add imaginary numbers and real numbers, the two form complex numbers, which enable physicists to write out quantum equations in simple terms. But whether quantum theory needs these mathematical chimeras or just uses them as convenient shortcuts has long been controversial.
>
> In fact, even the founders of quantum mechanics themselves thought that the implications of having complex numbers in their equations was disquieting. In a letter to his friend Hendrik Lorentz, physicist Erwin Schrödinger — the first person to introduce complex numbers into quantum theory, with his quantum wave function (ψ) — wrote, "What is unpleasant here, and indeed directly to be objected to, is the use of complex numbers. Ψ is surely fundamentally a real function."[1173]

Like it or not, the question of whether or not imaginary numbers were needed turned out to not be optional. The necessity of imaginary numbers for quantum mechanics has finally been experimentally proven true in recent experiments based on quantum entanglement.

> Now, two studies, published Dec. 15 [2021] in the journals Nature and Physical Review Letters, have proved Schrödinger wrong. By a relatively simple experiment, they show that if quantum mechanics is correct, imaginary numbers are a necessary part of the mathematics of our universe.[1174]

Imaginary numbers reflect the spookiness in quantum entanglement. Mathematically, imaginary numbers reflect an inability to find reality in observable results which we know cannot be bridged by some undiscovered 'real'-ity or ontology. Another way to think of an imaginary number is that it represents whole bodies of exformation which have influence on the act of observation of a phenomenon. And, they do not have to be numbers. They can also be functions with much more complicated mathematics. But for now, let's just look at a simple complex number and how it could be used to generate a real number.

Any complex number would look like a real part + the imaginary part that might look something like this: 0.5 + 0.25i. The real part is 0.5 and the imaginary part is 0.25i or 0.25 X . You can see the problem. There is no square root of minus one, undefined. So how would you combine these numbers to get a real result? Here is how we can use it to get a real number we can use. To find an amplitude we square both the real part and the imaginary part. If we square the real part, 0.5^2 we get 0.25. When we square the imaginary part, we get $0.25^2 = 0625$. Therefore, the result is $0.5^2 + 0.25^2 = 0.25 + 0.0625 = 0.3125$. So, one way of getting rid of the impossibility of combining a real number and a complex number is by squaring the square root of -1 to get a real number.

Both real and imaginary numbers comprise probabilities of the reality we ultimately observe. If we have a whole series of experimental observations of how quantum events have likely happened in a particle accelerator, we may be able to specify some

kind of probable event that may occur in certain situations. In quantum mechanics the 'probability amplitude' is the probability of detecting a particle at some point. The time-dependent Schrödinger equation gives us a clue as to how probability amplitudes might change with time. The Schrödinger equation gives us a linear result of probabilities which cannot be added together to get a resultant probability because the probability is a complex number. However, the amplitudes of the probability of detecting a particle at a certain point can be summed together. The amplitude of the probabilities is squared as in the example above getting rid of the complex part to give us the amplitude, magnitude, or if you will confidence that a certain particle may be found at a certain location and time.

> In quantum mechanics, motion is represented not by a trajectory but by a wave function. This function is a probability wave or, to be more exact, a "probability amplitude" wave, which means that the square of the amplitude module of the wave function at some point provides the probability of detecting a particle at this point. The change in time of this probability wave is defined by the Schrödinger equation. This equation is a linear equation, i.e., the sum of two of its solutions is also a solution. Thus, the amplitudes of the probabilities are summed but not the probabilities themselves. The probability is defined by the square of the amplitude (Bohr's rules), which introduces nonlinearity into the wave function evolution process despite the linearity of the Schrödinger equation. [1175]

Here is a more technical explanation,

> According to the superposition principle of quantum mechanics, wave functions can be added together and multiplied by complex numbers to form new wave functions and form a Hilbert space. The inner product between two

> wave functions is a measure of the overlap between the corresponding physical states and is used in the foundational probabilistic interpretation of quantum mechanics, the Born rule, relating transition probabilities to inner products. The Schrödinger equation determines how wave functions evolve over time, and a wave function behaves qualitatively like other waves, such as water waves or waves on a string, because the Schrödinger equation is mathematically a type of wave equation. This explains the name "wave function", and gives rise to wave–particle duality. However, the wave function in quantum mechanics describes a kind of physical phenomenon, still open to different interpretations, which fundamentally differ from that of classic mechanical waves.[1176]

Superposition is a combination of all possible states of a qubit until it is observed or measured. When it is not being observed or measured, it has no definite state. It has a hazy state between existence and nonexistence. This has also been thought of as all possible states. By 'all possible states' we can mean that "*a qubit can have infinite states, but when you measure it, it's still either a 1 or a 0.*" [1177]

> Imagine touching the surface of a pond at two different points at the same time. Waves would spread outward from each point, eventually overlapping to form a more complex pattern. This is a superposition of waves.[1178]

The most fundamental unit of quantum information is called a "qubit" for quantum bit. However, the qubit is different from our standard computer bit. Our current computer bits have two states, zero and one. The qubit can have infinite states simultaneously while in superposition or when it is not observed. Let's start with a single qubit which is not entangled. The unentangled qubit is a

loner. It is not correlated to any other qubit. Before our qubit is measured or observed the quantum wave function tells us that in superposition, before observation, the qubit can be in any or all states between and including the integer zero or one. In other words, the qubit measurement can be all real numbers between and including zero and one. That is, it can have an infinity of values simultaneously, e.g., 0.12345… or 0.98456…etc. However, when measurement occurs or 'actually observing' the wave function of a single qubit, the superposition state collapses and the observer actually measures a definite value which, like traditional bits, is either a zero or a one. So, while quantum computers typically operate on entangled qubits, individual qubits can still serve useful purposes. For example, during development and testing, a single qubit can be employed to explore quantum algorithms and verify their behavior without the need for a fully entangled system. 1179 However, the immense power of a qubit occurs when multiple qubits are entangled.

The quantum wave function is entanglement. And as not "***one [property of quantum mechanics] but rather the characteristic trait of quantum mechanics, the one that enforces its entire departure from classical lines of thought***". (Schrödinger, 1935, p. 555) we are standing at the precipice of a vast chasm which gave rise to the cosmos, to all our *is'es*, to expanding complexity and novelty we call the Big Bang singularity and the expanding universe adding novel degrees of freedom, responsible for 'un'-natural selection where complexity produces accidents in various temporalities leading to more complex adaptations, ever new, ever renewing itself an emergence which cannot belong to any categories of decoherence. Decoherence *is* classicism. Decoherence *is* cause and effect. Decoherence *is* historic narratives. And quantum physics has turned back the veil of classicism.

Quantum computing as multiple entangled qubits is not metaphysics. Quantum computing is not theoretical. There are already multiple quantum computers with entangled qubits and the

number of qubits in each quantum computer is increasing all the time. As of now, there are several quantum computers in existence, each with varying numbers of qubits. Notably, Atom Computing has developed a groundbreaking machine with 1180 qubits—the largest to date! Unlike traditional superconducting qubits, Atom Computing's design uses neutral atoms trapped by lasers in a 2D grid, which allows for easier scalability and rapid growth in qubit count. Quantum entanglement enables qubits to be interlinked. When qubits are entangled, their properties become correlated, allowing them to process and store information in ways that vastly surpass classical computers' capabilities.

IBM tells us that an achievable goal by the year 2033 is 100,000 entangled qubits. [1180] A company in Palo Alto called PsiQuantum is working on building a million-qubit quantum computer with IBM. [1181] Australian researchers are working on putting millions of entangled qubits on one chip. [1182] Listen folks, all of us have laughed and been entertained by the science fiction theme that we could create universes. This is no longer science fiction. Quantum computing is the vehicle that will take us there. And even if we as a species cannot make it there, quanta have already and will continue to churn out universes (e.g. Big Bang) and much more. The math of qubits is beyond the scope of this book. Therefore, I want to give an analogy of why quantum computing is so different and so much more powerful than anything we have ever known.

Waves are a good example for quantum particles because quantum particles can be thought of as waves interacting with each other just like waves in water. Waves can have constructive interference which adds to the amplitude of the resulting wave or destructive interference which subtracts from the amplitude of the resultant wave. So, if we add or subtract all the constructive wave amplitudes and destructive wave amplitudes, we will get the resulting wave amplitude. But water waves have no spooky superposition state in which "…*not alternatives but all really happen simultaneously*". [1183]

Let's imagine that problems to be solved are more like waves than particles. If we think of particles like a billiard ball, our traditional way of solving complex problems in the past was to set up numerous balls to simulate a real-world condition then start them in motion with multiple balls bouncing off each other in a cause-and-effect type fashion to see if we can follow all the complex interactions to a conclusion, to a solution of a complex problem. The problem we run into is the complexity becomes unmanageable. This is more like the tactic our conventional computers employ. As a note, this is also why tracking constantly mutating proteins in the human body makes traditional computation schemes impossible to address when the proteins go wrong and cancer results. But quantum computing will solve these types of problems and cancer will be a thing of the past. More on this later.

Now, let's imagine that instead of particle-like billiard balls we start with waves. Complexity is already built into waves without having to understand every discrete interaction. Waves have prominent features like amplitude and frequency along with many other undulating characteristics. When one wave interacts with another wave, one tide interacts with another tide, we do not have to dissect every dynamic occurring in the interaction but nevertheless we can see new patterns emerging. The beauty of qubits is that extremely complex interactions, patterns of waves, can be brought together as complex waves without dissecting them into all the component parts. And, we can keep on adding qubits or chain more complex wave patterns together over a sequence of varying experimental conditions and beautifully, all in the quantum wavefunction without localizing, dissecting them at each step along the way, piecing them back together, and in the end the quantum universe gives us a yes or no answer, zero or one. The chain of wave-like interactions is not observed, decohered, until we reach a yes or no conclusion. The old billiard ball way was sort of like trying to breathe life into Frankenstein or putting Humpty-Dumpty all together again in order to move on to the next fall off the wall.

With qubits all these interactions happen in the wavefunction as intermingling waves, and the beauty is that when all is said and done, the universe gives us a yes or no answer. That is way cool! After the first run through we can repeat the experiment the same way many times to get a statistical analysis, a relative certainty, of the strength of the yes or no answer. This metaphor is how highly complex wave functions can be combined to interact with each other using qubits to far exceed our current computational capabilities. With that in mind let's get into a few details.

Density fields which only give us probabilities of finding a wavicle do not have the certainty of finding a wavicle only a probability that there is a high enough density in the field at a certain time of finding the particle portion of the wavicle. One additional point to make here is that all the probabilities, the temporal constructive and destructive results of probability density amplitudes must add to one. If I flip a coin, there is a 50% probability that it will come up heads or a 50% probability it will come up tails which adds up to 100% or 1. Therefore, we can shorthand the equation below as the sum of the square of all probabilities will always equal one or in standard mathematical nomenclature,

Why are quantum computers faster than conventional computers? [1184]

For one thing, when we add bits to a classical computer processing power goes up linearly. When we add qubits to a quantum computer processing goes up exponentially. Let's look at how two qubits on a quantum computer can process much more efficiently than two bits on a classical computer. In simplistic terms, think of the electron spinning like a top.

Actually, this is not really a spin like we typically think of spin but angular momentum. Angular momentum might be thought of like a pole of a magnet attracting the electron in an angular direction. The electron has a preference for moving *as if* a magnet

were pulling it angularly. However, spin is not external to the electron but an internal propensity towards an angular direction caused solely by the electron. The angular momentum of an electron can be clockwise or counterclockwise. We could call clockwise 1 and counterclockwise 0. But one qubit can have an infinite number of states until it is measured upon which it will be a 0 or a 1. With bits we only have two possibilities, zero and one. Qubits can be thought of as a sphere which has a north pole and a south pole. In superposition all points on the sphere are in play simultaneously. Upon observation either one of the poles, north or south, zero or one, are observed. Additionally, at the equator of the sphere the probability is 50/50 that one or the other poles, will be observed as a zero or one. Qubits are *normalized* which means their observed values upon wavefunction collapse must exist and be finite, not infinite or indeterminate.

It is the entangled superposition state of qubits which makes them much more powerful than a standard bit. Qubits are constructed in such a way that they measure upon wavefunction collapse as a zero or one. The mechanics of this can be thought of in terms of the quantum property of spin. Spin can be up or down, only two states, in an elementary particle. Before observation electron spin is all possible values simultaneously. Therefore, a discrete spin of up or down measured upon wavefunction collapse can be represented as a zero or a one. This is called a qubit two-level system. The polarization of a photon can also be used for a two-level system (lefthand or righthand circular polarization). However, qubits need not be based on two-level elementary particle properties. Qubits can also be constructed based on multilevel properties of elementary particles like charge or mass. 1185

To illustrate the immense power unleashed by qubits let's compare qubits to standard computer bits. The ability for qubits to retain such vast amounts of exformation, highly entangled information, allows them to solve much more complex and even impossible problems with our current technology. In the upcoming

section, “How a Bit of IT Named Qubit Got Out of a Maze”, we will see a very practical way all this works and why it works so much faster than classical computers. Since qubits think in terms of complex math it would take a lot of classical hardware or software to do these kinds of complex matrix operations.

The chart below gives a comparative scale of # of qubits to # bits to conventional storage size (RAM).

# of qubits	# bits	RAM
1	2	2 bits
2	4	4 bits
3	8	1 byte
4	16	2 bytes
5	32	4 bytes
6	64	8 bytes
7	128	16 bytes
8	256	32 bytes
9	512	64 bytes
10	1024	128 bytes
11	2048	256 bytes
12	4096	512 bytes
13	8192	1 kB

1186

The chart below gives a comparative scale of # of qubits to # bits to memory required (RAM) to how much time (Time) a classical computer would use for similar computational abilities.

# of qubits	# bits	RAM	Time
13	8192	1 kB	2.73x10-6 s
20	1048576	128 kB	3.5x10-4s
23	8388608	1 MB	2.8x10-3s
33	8589934592	1 GB	2.9 s
43	8.8x1012	1 TB	49 mins
53	9.0x1015	1 PB	35 hours
63	9.2x1018	1 EB	97.5 years
1000	1.1x10301	1.3x10282 EB	1.1x10284 years

1187

Think about this:

63 qubits contain as much classical bits as an Exabyte of data.

By comparison 63 bits is just under 8 bytes. Just enough

to store 8 characters!

If we look at it from an execution time perspective, it would take a century to simulate an operation on 63 qubits.

We added the thousand qubits row to show where this trend is going.

10301 classical bits is a staggering number of bits. For reference, it is believed the universe contains 1080 hydrogen atoms. So we would need more than three universes worth of hydrogen atoms to store those bits!

Operations on a thousand qubits would take 10284 years to simulate. The age of the universe is estimated at 13 billion (1.3x1010) years. Hence we would need to wait 28 times the current age of the universe to achieve that! 1188

In superposition a qubit has no definite state and is absolutely indeterminate not because we just have not figured it out yet (as classicism would maintain) but because it cannot be said to exist or not exist. As I have discussed, exformation is not causal. It becomes causal upon observation in spacetime, but it has an exteriority to spacetime which Einstein called spooky. I call it a yawning gap, an abyss, chaos. Qubits and exformation have an exteriority which finds no language, no history, no classicism. It simply does not fit into any 'thing'. The best way to think about exformation is as an excessive exteriority…something which finds no place, no time, no explanation but is not nothing or something either. It is not mere negation of everything. It is not anything which can be thought of as 'is' or anything that can be thought of as 'is not'. Therefore, its ontological status is indeterminate. Neither can it be thought of as actual knowledge or potential knowledge as if one day we will understand the truth of how it works. It is absolutely alien to the notion of truth or falsity. Therefore, its epistemological status is indeterminate. Everything we can imagine as anything emerges from this hazy and spooky…fog which all to easily slips into existence/Being, nonexistence/nothing, truth/falsity, potential/

actual, cause/effect, etc. Novel emergence from chaos is what one of the greatest minds in human history simply called spooky.

A Deeper Dive – Calculating a Qubit

Here is a quick example of calculating the wave function of a qubit. A qubit is a property of a quantum particle. Qubits can use the spin property. A qubit can be in a kind of superposition state called a 'coherent superposition'. For qubits this means that the quantum property state can be zero or one or a superposition of zero and one. When a qubit is measured it collapses the superposition state and it will be a particle which can only have two values, a value of zero or a value of one. But we cannot specify a real value for the quantum wave function (ψ) itself because it is a complex function. This means we cannot know exactly what the real value would be, but we can know the probability of what the real value will be. Here is how we would calculate the wave function of a qubit. First, a word about commonly used notation in quantum states called *bra-ket*.

The *bra-ket* notation, also known as Dirac notation, is a standard notation used in quantum mechanics to represent quantum states, vectors, and linear operators on complex vector spaces together with their dual space both in the finite-dimensional and infinite-dimensional case. It was introduced by Paul Dirac in his 1939 publication "A New Notation for Quantum Mechanics". The notation uses angle brackets, | and ⟩, and a vertical bar, ⟨, to construct "*bras*" and "*kets*". A *ket* is of the form |ψ⟩. Mathematically, it denotes a vector, ψ, in an abstract (complex) vector space, and physically, it represents a state of some quantum system. A *bra* is of the form ⟨ψ|. Mathematically, it denotes a linear form, i.e., a linear map that maps each vector in the vector space to a number in the complex plane. The purpose of this linear form can now be understood in terms of making projections on the state to find how linearly dependent two states are, etc. [1189]

A qubit is a two-level quantum system that can be in a superposition of two states, denoted as $|0\rangle$ and $|1\rangle$. The wave function of a qubit can be written as a linear combination of these two states, each with its own complex coefficient. For example, a qubit in the state $|\psi\rangle$ can be written as:

$$|\psi\rangle = \alpha|0\rangle + \beta|1\rangle$$

where α and β are complex numbers that satisfy the normalization condition $|\alpha|^2 + |\beta|^2 = 1$.

To calculate the wave function of a qubit, we need to find the coefficients α and β that correspond to the state of the qubit. For example, if we have a qubit in the state $|\psi\rangle = (|0\rangle + |1\rangle)/\sqrt{2}$, then we can see that $\alpha = \beta = 1/\sqrt{2}$. Here's a simple example of how to calculate the wave function of a qubit:

Suppose we have a qubit in the state $|\psi\rangle = \alpha|0\rangle + \beta|1\rangle$, where $\alpha = 1/\sqrt{3}$ and $\beta = \sqrt{2}/\sqrt{3}$. To calculate the wave function of this qubit, we first need to normalize the coefficients:

$$|\alpha|^2 + |\beta|^2 = (1/\sqrt{3})^2 + (\sqrt{2}/\sqrt{3})^2 = 1$$

Next, we can write the wave function of the qubit as:

$$|\psi\rangle = (1/\sqrt{3})|0\rangle + (\sqrt{2}/\sqrt{3})|1\rangle$$

The square root of 3 = 1.7320508075689.

The square root of 2 = 1.4142135623731

Let's solve for the values,

$1/\sqrt{3}$ = 0.57735026918961819568496422776981 but we need to square this so $(1/\sqrt{3})^2$ = 0.33333333333332459360797253245138

$\sqrt{2}/\sqrt{3}$ = 0.81649658092771818737429283920698 but we need to square this so $(\sqrt{2}/\sqrt{3})^2$ = 0.66666666666665385525047960144702

The result of the calculation tells us there is a 33% (rounded off two places) chance that the measured value will be 0 and a 67% (rounded off two places) that the measured value will be 1. This is the wave function of the qubit in terms of the basis states $|0\rangle$ and $|1\rangle$.

However, interesting things happen when two qubits are entangled.

Now let's say we have two qubits which are entangled. An interesting Scientific American online article entitled "How to Fix Quantum Computing Bugs" [1190] there is an interesting chart detailing bits versus qubits. It turns out that if we measure both entangled qubits individually our measurements will turn out to be totally random because measuring both qubits results in two unentangled qubits. However, if we measure only one qubit of an entangled qubit pair, the other qubit will be totally correlated with the qubit we measured. In other words, let's say we measure one qubit of the entangled pair. Our entangled pair has spin that is always correlated in opposite directions. **Note that correlation does not mean 'the same value'.** Correlation means they act the same way relative to each other. So, commonly, an entangled spin pair would always have one particle with spin up and the other entangled particle with spin down. So, we measure one side of an entangled particle, and we get a value of zero. As long as we do not measure the other qubit, we can be confident that the other qubit's value is one. However, if we actually try to measure or observe the qubit whose value we deduced to equal one, we will destroy the entangled pair and each one of their values will now be random and uncorrelated.

Remember, the value of the qubit in superposition can be any value between and including zero and one. There are infinite real number values between zero and one. However, as entangled or correlated we can surmise that if one value is 0.25 the other value will be 0.75. In other words, as normalized and correlated both values must add up to one. This is "spooky action at a distance".

The entangled correlation occurs no matter how far away the entangled qubits are to each other. Additionally, the entanglement has nothing to do with time. There is no time or space between the two entangled bits. Our standard bits in current computers are purely binary so their values will always be a zero or a one. There are many more possible values for qubits. This makes them much more powerful than our standard bits.

Quantum Computers and Extending Entanglement

Currently some quantum computer technologies have to be supercooled to temperatures ranging from 0.02 Kelvin to recently shown 257.07 Kelvin [1191] above absolute zero to prolong entanglement. Interestingly enough, very high temperatures like in fusion, the temperature of the sun, are more conducive to prolonging quantum entanglement. This is due to the fact that the frequency of vibration as heat is so rapid that wavicles spend more of the time in a state of chemical fusion.[1192] Electromagnetism can also be utilized to reduce errors and maintain entanglement. Entanglement only needs to be preserved long enough for error correction and complexity theory are able to rebuild the entangled exformation. What is very interesting is that our brains found a way to preserve entanglement with error correction and complexity theory long before we ever thought about any such thing as entanglement. Our brains do it by incessantly extending entanglement long enough for tearing down and rebuilding neurons recreating exformation. There are current studies suggesting that brain chemistry and its associated electromagnetic effect may cause long enough coherence of entangled brain particles.[1193] Also, high density materials like artificial diamonds are a promising new avenue for preserving entanglement. Additionally, NASA is already conducting quantum computing experiments in space since entanglement lasts longer in very cold temperatures and in a vacuum.[1194] When hydrogen is cooled to very close to absolute zero

it creates a condensate called Bose-Einstein Condensate.

> Every Bose-Einstein condensate is in a highly entangled state, as a consequence of the fact that the particles in a condensate are distributed over space in a coherent way. It is proved that any two regions within a condensate of finite particle number are entangled. This entanglement does not depend on the distance between the two regions. Criteria for the presence of entanglement are derived in the context of interference experiments. For separable states there is a trade-off between fluctuations in particle number and interference visibility.[1195]

The Bose-Einstein Condensate is a highly coherent entangled system and could be used for quantum computing.

> Quantum entanglement was discovered by Schrödinger and later studied by Einstein and other scientists in the last century. It is a quantum phenomenon that has no counterparts in classical physics. The groups of entangled particles lose their individuality and behave as a single entity. Any change in one of the particles leads to an immediate response in the other, even if they are spatially separated. "Quantum entanglement is essential in applications such as quantum computing, since it enables certain tasks to be performed much faster than in classical computing," explained the leader of the Quantum Information Theory and Quantum Metrology group Géza Toth.[1196]

Quantum Technologies and Companies

Many types of atoms have been investigated for use in quantum computing. Currently, quantum computers are expected to utilize

one hundred qubits. However, eventually quantum computers are expected to utilize thousands of qubits. Higher orders of qubits exponentially increase problem solving well beyond capacities of classical computing technologies.[1197] Atoms are the heart of qubits.

Silicon atom-based technologies are becoming increasingly more popular for implementing qubit technology.[1198] However other technologies have been utilized including graphene which is based on carbon atoms[1199] Several superconductor technologies for quantum computers are niobium and tantalum atoms.[1200] Boron atoms have also been utilized. Atoms with less isotopes are more stable and have advantages for quantum computing. For example, a silicon atom can have three isotopes. While its stable atomic number is 14 protons and neutrons, it can also have 15 and 16 neutrons and still remain a silicon atom. Isotopes like this can create tiny magnetic fields which hamper the stable operation of qubits. [1201] In using the term stable, I mean that entanglement can last for longer periods preventing faster decoherence. Oh, and just in case you might think quantum computing is some kind of esoteric notion, here is a partial list of companies actively developing quantum computing:

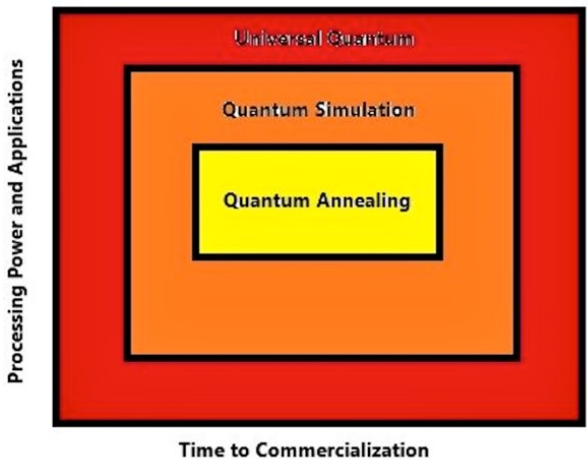
AbaQus, Accenture, AEGIQ, Agnostiq, Alice&Bob, Aliro Quantum, Alpine Quantum Technologies, Amazon, AmberFlux, Airbus, AT&T, Atom Computing, Aliyun (Alibaba Cloud), Atos, AUREA Technology, Automatski, Baidu, Bleximo, BOLTZ.AI, Booz Allen Hamilton, Boxcat Inc., BT, Carl Zeiss AG, Classiq, CogniFrame Inc, ColdQuanta/Infleqtion, ColibrITD, Cube Robot X, D-Wave, eleQtron, Elyah, Entropica Labs, Fujitsu, Google QuAIL, HP, Hitachi, Horizon Quantum Computing, HQS Quantum Simulations, HRL Laboratories, Huawei Noah's Ark Lab, IBM, ID Quantique, imec, Intel, Infineon Technologies, ionQ, IQM Quantum Computers, KEEQuant, Kipu Quantum, KPN, Lockheed Martin, main incubator, MagiQ, Microsoft Research QuArC, Microsoft Research Station Q, Mitsubishi, Nanoacademic Technologies Inc., NEC Corporation, Next Generation Quantum, Nokia Bell Labs, Northrop Grumman,

NTT Laboratories, Nu Quantum, ParityQC, PASQAL, PsiQuantum, Q. BPO Consulting, Q.ANT, Qblox, QC Ware, Qilimanjaro Quantum Tech, Quantized Technologies Inc. (QTI), Qulabs.ai, QpiAI, QNu Labs, QRCrypto SA, QRDLab, Qrypt, Quandela, Quantagonia, Quantinuum (merger of Honeywell Quantum Solutions and Cambridge Quantum Computing), Quantum Benchmark, Quantum Benchmark Labs, QxBranch, Quantum Brilliance, Quantum Circuits, Inc., Quantum Computing Inc., Quantum Machines, Quantum Thought, Qubrid, QuEra Computing, Qunnect Inc., QuSecure, Raytheon/BBN, Rigetti Computing, Riverlane, Seeqc, Silicofeller, Silicon Quantum Computing, Terra Quantum, ThinkQuantum, Toshiba, Turkcell, Taqbit Labs Pvt Ltd, Universal Quantum, Zapata Computing, 1QBit, ColdQuanta Inc., Xanadu Quantum Technologies, Qubitrium, XeedQ, Entangled Networks[1202]

These companies would not be developing quantum computing if they thought it was some kind of vaporware. Here are areas actively being developed by these companies: [1203]

Algorithm
Applications
Chip Manufacturing
Classical Computing
Communication
Computing
Consulting & Engineering
Education
Hardware
Hardware design
Platform QaaS
Quantum Cryptography
Quantum Entanglement
Quantum Machines and Devices
Quantum Networks
Sensing

Quantum computing can come in different flavors for different applications. Here are three types of quantum computers currently in commercial development:



1204

Each outer level of the diagram above would contain the inner levels of functionality.

Quantum annealing is for specialized applications for specific problems. Volkswagen recently commissioned a quantum computer study with Google and D-Wave Systems to optimize traffic flows in the overcrowded city of Beijing, China. On a traditional computer this kind of operation could take thousands of computer years to complete. 1205

Quantum simulations can be used for simulating quantum mechanics which are computationally very complex. One area already discussed would be condensed matter physics. Even whole or parts of atoms like neutral atoms, ionization of atoms, polar molecules, electrons in semiconductors, superconducting circuits, nuclear spins, and photons are good candidates for quantum simulation. 1206

Universal quantum computing would be the hardest to build but would run general purpose applications like Windows of super-steroids. It would probably have to contain over 100,00 qubits and perhaps even 1,000,000 qubits. Algorithms for these computers have already been developed over a period of years. Artificial intelligence which would make science-fiction look mundane when combined with quantum computing would be effectively the equivalent of a super-high-powered human brain. But do not think of the stereotype of vast rational intelligence here, we are talking about a higher life form which may have to evolve emotionally and ethically as well as in Yuval Harari's book "Homo Deus" (human God) to be discussed a little later. 1207

Implementing Quantum Computing

Because quantum physics wants to interact with everything and anything in the most intimate, intricate, and spooky fashion, the greatest challenge is trying to find ways to limit environmental 'noise' for use in technology. Entanglement is incessantly interacting with quantum systems in novel emergent ways. Therefore, entangled systems are cohering and decohering behind the scenes in a spooky fashion to make everything we think of as '*is*' emergent as existence prior to spacetime as branching exformation. The fact that we are seriously developing quantum computers is itself quite mind-boggling.

> One of the greatest challenges involved with constructing quantum computers is controlling or removing quantum decoherence. This usually means isolating the system from its environment as interactions with the external world cause the system to decohere. 1208

Environmental disturbances which can cause quantum decoherence for qubits can come from a number of sources.

Quantum technology needs something called ‘gates’ to make it usable. Gates perform specific operations depending on the type of gate. Gates can be made of standard integrated circuits or specialized quantum circuits. These gates can emit noise which negatively impacts coherence for qubits. Condensed matter such as crystalline atoms are used in superconductivity and superfluidity. This is a large area of study in physics which has applications in nanotechnology and quantum computing. Condensed matter physics studies emergent qualities tightly coupled, highly dense atoms. They can be supercooled which prolongs entanglement. However, even at temperatures close to absolute zero kelvin they still have electromagnetic forces which cause the atomic lattices to vibrate.

Quantum vibrations can be complex and random resulting in mathematical infinities and complexities. However, this does not exclude understanding ways to reduce these vibrations. For example. If they happen in certain high frequency ranges, they can be squelched to some degree. Also, in condensed matter physics these vibrations can have oscillator-like characteristics which approximate lattice-like mathematics. Understanding these vibrations goes a long way towards neutralizing them to some degree to prevent environmental disturbances to entangled qubits.[1209] Atomic ionization such as when atoms gain or lose neutrons but not their atomic number also impacts coherence detrimentally. Cosmic rays emitted by the sun can ionize atoms making them unstable for qubit applications.

> However, other sources of decoherence also exist. Examples include the quantum gates, and the lattice vibrations and background thermonuclear spin of the physical system used to implement the qubits. Decoherence is irreversible, as it is effectively non-unitary, and is usually something that should be highly controlled, if not avoided. Decoherence times for candidate systems in particular, the transverse relaxation

> time T2 (for NMR and MRI technology, also called the dephasing time), typically range between nanoseconds and seconds at low temperature. Currently, some quantum computers require their qubits to be cooled to 20 millikelvin (usually using a dilution refrigerator) in order to prevent significant decoherence. A 2020 study argues that ionizing radiation such as cosmic rays can nevertheless cause certain systems to decohere within milliseconds.[1210]

Hardware Platforms for Qubits

There are at least seven types of hardware platforms which run qubits: [1211]

Superconducting Qubits can use materials like metals, ceramics, organic materials, or heavily doped semiconductors in purer forms called condensed matter which are cooled to cryogenic, near absolute zero kelvin, temperatures. Superconductors have no resistance to current flow so they can handle large amounts of current without melting wires.

> Superconducting qubits are implemented by placing a resistance-free current in a superposition state, using a microwave signal, as it oscillates around a circuit loop. This qubit implementation is the most common, and is the main focus of IBM and Google's universal quantum computers (among others). [1212]

Electrical current could float forever in a superconductor more like a perpetual motion machine. The odd thing about all this is that in traditional current flow single electrons flow in a wire like a Cooper pair. From the earlier discussion on electron spin we stated that electrons are fermions with half spin. However, in superconductors electrons flow in pairs and have integer spins like bosons. Effectively we have converted electrons from fermions to

bosons. [1213] Superconductors have a dual opposite called superinsulators. While superconductors offer no resistance to current flow, superinsulators offer infinite resistance to current flow. Both superconductors and superinsulators have magnetic fields. However, the strongest magnetic fields produced by traditional electromagnetic wire windings use a lot of energy to produce their fields. Superconductors create huge magnetic fields comparable to the largest traditional magnetic fields but use much smaller amounts of energy to achieve cryogenic temperatures without energy loss due to friction in traditional wires. Superconductors are currently used in MRI machines in hospitals, fusion reactors, particle accelerators, and even a magnetic levitation railway system being constructed in Japan. [1214] The interesting thing about superinsulators is that they are magnetic monopoles as opposed to magnetic dipoles which, as I discussed earlier, were thought to be present during the early cosmological inflationary period. [1215]

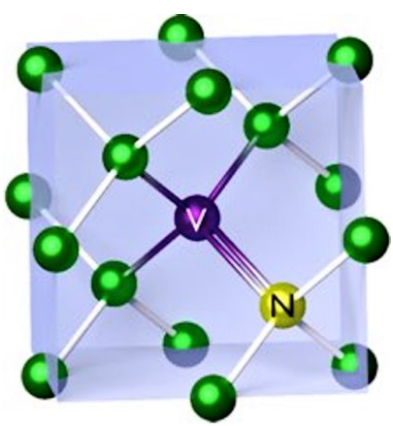
Quantum Dots Qubits are cryogenic nanoparticles made from materials like silicon, cadmium, selenide, cadmium sulfide, germanium, or indium arsenide. A quantum dot is an isolated spherical volume. It is typically a diameter of ten-thousands of a millimeter. The quantum dot has a free electron, not bound to an atom, but locked into place by an electromagnetic field. In a quantum dot the qubit as electron spin can be switched up or down electrically. The advantage of the quantum dot is that it will be able to fit hundreds of millions of qubits onto a chip.

Trapped Ion Qubits are atoms which have lost or gained electrons from their neutral state. When this happens to an atom it is called an ion. In the case of a calcium atom an electron is removed making the atom positively charged. This is called an ion trap. The number of electrons added or removed is equal to the number of qubits for that atom. Trapped ions can be entangled with each other. The advantage of ion traps is that coherence times are longer, and they will also support universal quantum computers.

Trapped ions are very stable in superposition states. It is also easier to measure the state of trapped ions qubits. This is done by applying a laser to the ion. The collapse of the quantum state of the ion may or may not release a photon depending on if the state changes or not. If the qubit changes its state, it will not release a photon. On the other hand, if the ion does not change its state, the collapse of exciting the ion releases a photon in ion decay from the energy burst given by the laser. The laser is applied multiple times and photon detectors count the photons being released. By counting the number of photons, the accuracy of the qubit state is greater than 99.9%.

Photonic Qubits do not have mass or charge and therefore, do not interact with each other. They have long coherent time and weak interaction with the environment. They have virtually no decoherence. They also work well in either cryogenic or room temperatures. Photons work at the speed of light, and they are polarized horizontally and vertically. This means they work well with optical components like phase shifters, beam splitters, and photon counters. They are ideal candidates for universal quantum computing.

Defect-based Qubits are based on what is called the nitrogen-vacancy of diamonds. Occasionally, a nitrogen atom can form in a diamond which causes there to be a missing carbon atom.



This vacancy has become a leading candidate for implementing qubits. The qubits are individually addressable. They can also be initialized, manipulated, and measured with great accuracy at room temperature.

Topological qubits are qubits described by a mathematics called topological. Topology mathematically describes physical changes and deformities as being twisted, compacted, or stretched while still maintaining its original properties. Think of it as describing the hardiness of a material. [1217] Ettore Majorana (1906-1959) was an Italian theoretical physicist who was highly gifted in mathematics. [1218] He only wrote nine papers. In 1932 one of his papers predicted the existence of a neutron which he called a neutral proton. In his last paper he posed the existence of an exotic particle which was a particle which had its own anti-particle. He thought the neutrino might be one of these exotic particles. Normally particles and anti-particles have opposite charges but since Majorana's had both, it was neutrally charged.[1219] In 2020 physicists at MIT and elsewhere observed the first evidence of this particle on the surface of gold. Majorana fermions would be an ideal candidate for qubits. In two separated and entangled Majorana fermions if one had noise errors the other Majorana fermion would not have noise. [1220] Because they are neutrally charged there would be no electromagnetic interference. Therefore, the topology of Majorana fermions is highly resilient and hardy. Microsoft is very excited about the topological qubit and has already started work on it. [1221]

Nuclear Magnetic Resonance Qubits are based on some atoms' neutrons which have a magnetic moment. Therefore, these neutrons interact with magnetic fields. This technology lies at the heart of Magnetic Resonance Imaging (MRI). Since the neutrons have magnetic moments, they have potential spin states of up and down. Additionally, since the entangled system of magnetically spin acts as a whole system, no longer defined by its parts, the spin states are

easily detectable. Additionally, a radio-frequency signal can flip the spin state. The spin states are robust and easily measurable. The spin states are easily changeable as well.

Gates

Quantum gates perform quantum operations. Quantum operations are performed in superposition. This means they are not like the gates in our current computers. In quantum computing, a quantum gate is a basic quantum circuit that operates on a small number of qubits. They are the building blocks of quantum circuits, like classical logic gates are for conventional digital circuits. Unlike many classical logic gates, quantum logic gates are reversible meaning inputs and outputs can be swapped and work in both directions. It is possible to perform classical computing using only reversible gates. Quantum gates are unitary operators and are described as unitary matrices relative to some basis. An orthonormal basis is a set of vectors that are normalized (i.e., have unit length) and perpendicular to each other. 1222 The concept of orthonormal basis is particularly useful in linear algebra and signal processing, where it is used to represent signals and data in a compact and efficient way. Usually, the computational basis is used, which means that for a d-level quantum system (such as a qubit, a quantum register, or qutrits and qudits), the orthonormal basis vectors are labeled $|0\rangle$, $|1\rangle$, ..., $|d\text{-}1\rangle$... or use binary notation. Quantum gates are represented by unitary matrices. A gate that acts on qubits is represented by a unitary matrix, and the set of all such gates with the group operation of matrix multiplication is the symmetry group $U(2^n)$. The unitary group of degree n, denoted U(n), is the group of $n \times n$ unitary matrices, with the group operation of matrix multiplication. The symmetry group U(2n) is a subgroup of the unitary group U(n) and is defined as the group of $2n \times 2n$ unitary matrices. The group U(2n) has many applications in physics, including in the study of quantum field theory and

quantum mechanics. It is also used in the study of Dirac fields and flavor symmetries. [1223] The most common quantum gates operate on vector spaces of one or two qubits, just like the common classical logic gates operate on one or two bits. [1224]

There are various kinds of physical operations that can be performed on qubits.

- Quantum logic gates, building blocks for a quantum circuit in a quantum computer, operate on a set of qubits (a register); mathematically, the qubits undergo a (reversible) unitary transformation described by multiplying the quantum gates unitary matrix with the quantum state vector. The result from this multiplication is a new quantum state.
- Quantum measurement is an irreversible operation, a classical operation, in which information is gained about the state of a single qubit, and coherence is lost. The result of the measurement of a single qubit with the state will be either a zero with its probability being its wave function's absolute value squared or a one with its probability being its wave function's absolute value squared. Measurement of the state of the qubit alters the magnitudes of α and β. If measurement is performed on a qubit that is entangled, the measurement may collapse the state of the other entangled qubits.
- Initialization or re-initialization to a known value, often zero. This operation collapses the quantum state (exactly like with measurement). Initialization to zero may be implemented logically or physically: Logically as a measurement, followed by the application of the Pauli-X gate if the result from the measurement was one. Physically, for example if it is a superconducting phase qubit, by lowering the energy of the quantum system to its ground state.

- Sending the qubit through a quantum channel to a remote system or machine (an I/O operation), potentially as part of a quantum network. 1225

A gate performs a logical operation. A Pauli X gate is an operation which simply flips a bit from one to zero or vice versa (like a classical NOT gate). A Hadamard gate places a qubit in superposition. There are also gates which connect multiple qubits and can be controlled by qubit states. Gates can swap qubits. Helper gates can be used for error correction. 1226

Here are examples of some of these gates below. The matrix column shows how the inputs and outputs are manipulated.

Operator	Gate(s)	Matrix
Pauli-X (X)		$\begin{bmatrix} 0 & 1 \\ 1 & 0 \end{bmatrix}$
Pauli-Y (Y)		$\begin{bmatrix} 0 & -i \\ i & 0 \end{bmatrix}$
Pauli-Z (Z)		$\begin{bmatrix} 1 & 0 \\ 0 & -1 \end{bmatrix}$
Hadamard (H)		$\frac{1}{\sqrt{2}}\begin{bmatrix} 1 & 1 \\ 1 & -1 \end{bmatrix}$
Phase (S, P)		$\begin{bmatrix} 1 & 0 \\ 0 & i \end{bmatrix}$
$\pi/8$ (T)		$\begin{bmatrix} 1 & 0 \\ 0 & e^{i\pi/4} \end{bmatrix}$
Controlled Not (CNOT, CX)		$\begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 1 \\ 0 & 0 & 1 & 0 \end{bmatrix}$
Controlled Z (CZ)		$\begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & -1 \end{bmatrix}$
SWAP		$\begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$
Toffoli (CCNOT, CCX, TOFF)		$\begin{bmatrix} 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 \end{bmatrix}$

1227

Notice that qubits just like our current computer bits can be many qubits wide (like 32, 64, 128 bits width in standard

computers). However, since qubits are not anything like bits.

> In classical computer technologies, a processed bit is implemented by one of two levels of low DC voltage, and whilst switching from one of these two levels to the other, a so-called "forbidden zone" between two logic levels must be passed as fast as possible, as electrical voltage cannot change from one level to another instantaneously.
>
> There are two possible outcomes for the measurement of a qubit—usually taken to have the value "0" and "1", like a bit or binary digit. However, whereas the state of a bit can only be either 0 or 1, the general state of a qubit according to quantum mechanics can be a coherent superposition of both. Moreover, whereas a measurement of a classical bit would not disturb its state, a measurement of a qubit would destroy its coherence and irrevocably disturb the superposition state. It is possible to fully encode one bit in one qubit. However, a qubit can hold more information, e.g., up to two bits using superdense coding.
>
> For a system of n components, a complete description of its state in classical physics requires only n bits, whereas in quantum physics a system of n qubits requires 2n complex numbers (or a single point in a 2n-dimensional vector space). [1228]

Below are some specifics concerning the gates listed on the table above.

- A Pauli-X gate is a single-qubit quantum logic gate that performs a bit-flip operation on the qubit. It is also known as the NOT gate. It is not an entangled gate, as it only operates on a single qubit.
- A Pauli-Z gate called a CZ gate can entangle its inputs. An entangled gate is a quantum logic gate that operates on

two or more qubits and creates entanglement between them. Examples of entangled gates include the Controlled-NOT (CNOT) gate and the Controlled-Z (CZ) gate.

- A Hadamard gate is a single-qubit gate that maps the basis states $|0\rangle$ and $|1\rangle$ to the states $|+\rangle$ and $|-\rangle$, respectively. It is not an entangled gate.
- In quantum computing, entanglement refers to the phenomenon where two or more qubits become correlated in such a way that their joint state cannot be expressed as a product of individual states. The tensor product of two Hadamard gates applied to two separate qubits does not produce an entangled state.
- A Phase (S, P) gate is a quantum logic gate that is used to introduce a phase shift of 90 degrees to the state of a qubit. It is not an entangled gate, but it can be used in combination with other gates to create entangled states.
- The $\pi / 8$ (T) or sqrtT gate, also known as the Rz(fracpi8) gate, is an entangling gate. It is a single-qubit gate that rotates the qubit state around the Z-axis by fracpi8 radians. It is used in many quantum algorithms, including the quantum phase estimation algorithm and the quantum Fourier transform.
- An entangling gate is a quantum gate that can create entanglement between two or more qubits. Entanglement is a fundamental concept in quantum mechanics that describes the correlation between two or more qubits that cannot be explained by classical physics. The CNOT gate is another example of an entangling gate. A Controlled Z gate can entangle its inputs which is entangled because the reduced density matrix of either qubit is maximally mixed.
- In general, the ability of a gate to cause entanglement is not related to whether it can be factored into a tensor

product of two matrices.

- The SWAP gate is not an entangled gate, however maximally entangling; more than one application of it is required to produce a Bell state from product states. The entangling power of an operator U describes the maximum entropy resulting from applying the operation to a bipartite input state. However, there are other ways to describe how much entanglement an operator introduces into a state.
- The Toffoli gate is an entangling gate in quantum computing. It is a three-qubit gate that performs a controlled-NOT operation on two target qubits, conditioned on the state of a control qubit. The Toffoli gate is also known as the CCNOT gate or the Deutsch gate.
- In contrast to classical logic gates, quantum logic gates are reversible and can be used to perform classical computing using only reversible gates. The Toffoli gate is a universal gate for classical computing, meaning it can implement all Boolean functions. The Toffoli gate has a direct quantum equivalent, showing that quantum circuits can perform all operations performed by classical circuits.
- An entangled gate is a quantum logic gate that operates on two or more qubits and creates entanglement between them. Examples of entangled gates include the Controlled-NOT (CNOT) gate and the Controlled-Z (CZ) gate. [1229]

What are the requirements for a good quantum computer?

It achieves quick gate operations: The desire for a quantum computer to demonstrate quick gate operations should be non-controversial. This metric should be considered in the context of gate fidelity and qubit coherence. Speedy gate

operations are only helpful if information is appropriately preserved.

Note: To get a feel for how these factors interact with each other you can observe that Superconducting implementations have shorter qubit lifetimes but faster gate operations than Ion Traps.

Operations achieve high gate fidelity. Classical computers use electrical signals that represent bits that are zero or one. If the signal experiences noise (e.g. from heat) and the signal doesn't represent precisely zero (for the sake of argument let's say 0.0004), then it's easy to attenuate the noise so that 0.0004 is treated as zero. Qubits need to precisely represent numbers (or more strictly amplitudes!) that are not just zero and one, so it is not possible to attenuate noise in such a way. The more logic gates you add to a quantum computer, the more noise builds up (which by definition cannot be attenuated). Therefore a good quantum computer demonstrates high gate fidelity where information is precisely preserved between operations.

High degree of scalability. We have left this until last to highlight that much of the factors above pertain to the inherent "noise" that must be grappled with in quantum computing systems. Quantum Computers will only be useful if we can achieve high gate fidelity and connectivity. Much research is going into understanding how to reduce noise through error correction. Once we have worked out how to build noise-free qubits (known as logical qubits) a key focus of further development will simply be on how we can scale up quantum computers to include more qubits (whilst preserving connectivity and minimising noise).[1230]

But quantum computers are prone to many types of errors that our current computers do not have. This requires very stringent error correcting techniques. One reason for errors is because

entanglement times are very short before something inevitable in the environment creeps in to decohere the qubits. But collecting information to determine if an error occurred introduces errors since that requires a measurement and measurement causes state reduction of the wave function (collapse, branching, etc.). One way to get around this problem is to have 'helper qubits'. If the helper qubits can be read the pristine state of the primary qubits need not be read. The helper bits can still show the current probable state of the primary qubits.

Another promising way to do error corrections is with something called anyons. A Scientific American article 1231 reports that anyons are topological quantum codes. These kinds of codes go back to 1982 and Frank Wilczek at MIT. Wilczek believed that the universe may contain an entirely different kind of particle. Recall from the Elementary particle table that all the particles had integer and half integer values of angular momentum. Wilczek believed that fractional values in between integer and half integer values of angular momentum were possible. This would be a new breed, and he cautioned that "practical applications of these phenomena seem remote." He called these "anyons".

Not long after, physicists figured out how to use anyons to determine entangled values in superposition without decohering them into classicism. Even more, physicists soon figured out how to fabricate qubits physically in lattice structures intermingled with helper qubits. This made having multiple entangled qubits with error correction live up to its incredible performance potential. There is a particular type of qubit gate which makes some gates very easy to protect against errors. This is called a transversal gate. There are two basic types of gates: transversal and non-transversal.

The Scientific American article reports that some of the new gates protect against errors. These are called transversal gates. These gates have two levels of description: the logical unit which protects a unit of information and the physical qubits. The physical qubit is the hardware required to protect the unit of information.

An error protected, one qubit, transversal gate encodes the logic qubit on all the physical qubits. If there are multiple logical qubits the transversal gate is placed between multiple logical qubits. A multiple logical qubit is really an array of logical qubits. For illustration purposes, logical qubits are two blocks of physical qubits called A block and B block. As an example, let's have two multiple logical qubits, two separate arrays of qubits. To perform error correction on these types of multiple logical gates, the transversal gate would go between qubit 1 of A block and qubit 1 of B block, qubit 2 of A block and qubit 2 of B block, and so on until all qubits in the perspective blocks of the arrays are covered by the transversal gate. This scheme preserves the current number of errors and inhibits the proliferation of more errors making the errors more manageable.

The non-transversal gates are much more difficult to manufacture. They require something called 'magic states'. Quantum computing is further complicated by the need for non-Clifford gates which would reduce the high overhead cost of *simulating* non-Clifford gates with more standard Clifford gates which again must utilize *magic states*. A magic state is a pure state. But getting the magic state to be pure requires an intensively computational process called distillation. If distillation is used it requires 99% of the overall computational power for the non-transversal gate.

99% of the computational power is too high a price to pay and a theorem in quantum error correction tells us that error correction cannot be achieved using only transversal gates. To dispel a myth just because we have superposition and entanglement does not mean that we cannot simulate some of these processes using classical bipolar gates Clifford gates. But the number of gates needed can be enormous and not practical. But non-Clifford gates tend to not be transversal and are really difficult to simulate classically. But this brings into play non-Clifford gates which use something called magic state distillation.

A non-Clifford implementation simulating superposition and entanglement requires a special kind of difficult-to-achieve gate which is in what is called a magic state. It is called ‘distillation for a reason’. It is a long arduous process to achieve white lightning. The state achieved must be very pure, having very few errors. The process starts with a noisy, error corrected Clifford gates. The process to reduce the noise must be repeated many times to end up with a pure state Clifford gate. These gates are like a flawless mirror. Using a process called teleportation (remind you of a wormhole?) the original qubit’s state can be mirrored by the pure state Clifford gate without using a transversal gate. This process destroys the magic pure state of the Clifford gate. The mirror gets broken in the process, but the qubit is preserved. Again, this process is costly consuming 99% of the computation. So, instead of error correct, why not use error mitigation at least for present development?

Error mitigation uses classical computers to learn the flavor of noise from noisy experiments and simply do a kind of noise-cancellation. By characterizing the noise, we can reduce the proliferation rate of errors. The quantum algorithm can be run a number of times to better assess the noise and reduce the error proliferation rate even more. There are limitations to this technique. It will not work with all algorithms. It may work better with smaller quantum computers. But it is promising at least in the interim of quantum computing.

Algorithms

Quantum algorithms are a type of algorithm that can be run on a quantum computer. They are designed to take advantage of the unique properties of quantum mechanics, such as superposition and entanglement, to solve certain problems faster than classical algorithms.

> Quantum algorithms are most commonly described by a quantum circuit, of which a simple example is shown in the figure below. A quantum circuit is a model for quantum computation, where the steps to solve the problem are quantum gates performed on one or more qubits. A quantum gate is an operation applied to a qubit that changes the quantum state of the qubit. Quantum gates can be divided into single-qubit gates and two-qubit gates, depending on the number of qubits on which they are applied at the same time. Three-qubit gates and other multi-qubit gates can also be defined. A quantum circuit is concluded with a measurement on one or more qubits. [1232]

Quantum algorithms are usually described in the commonly used circuit model of quantum computation, by a quantum circuit which acts on some input qubits and terminates with a measurement. Some of the best-known quantum algorithms include Shor's algorithm for factoring and Grover's algorithm for searching an unstructured database or an unordered list. Although all classical algorithms can also be performed on a quantum computer, the term quantum algorithm is usually used for those algorithms which seem inherently quantum or use some essential feature of quantum computation such as quantum superposition or quantum entanglement. Quantum algorithms can be categorized by the main techniques used by the algorithm. Some commonly used techniques/ideas in quantum algorithms include phase kick-back, phase estimation, the quantum Fourier transform, quantum walks, amplitude amplification and topological quantum field theory. [1233]

How a Bit of It Named Qubit Got Out of a Maze

Let's think of a practical example. Suppose we have a huge maze, and we want to find the fastest way out of the maze. A normal computer would have to calculate by brute force the time it would

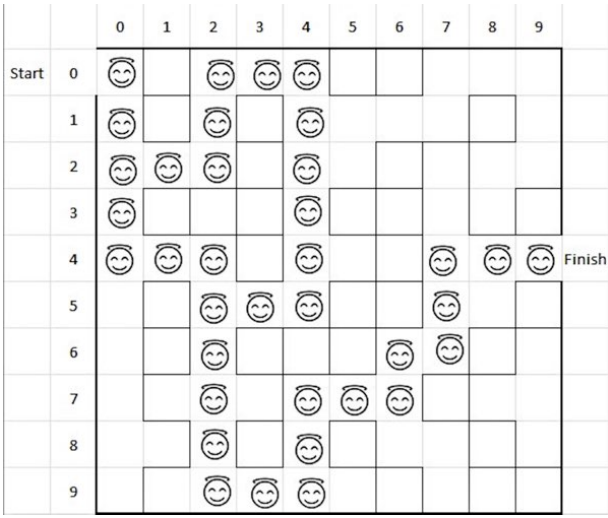
take for all possible routes to get out of the maze in order to definitively decide which route was the fastest way out of the maze. In superposition, a quantum computer would 'know' all routes simultaneously, a-temporally, and upon decoding, or observation, would tell us the probability of the fastest route through the maze. This sounds esoteric and witchy to our historic ears but *phusis* works this way behind the scenes.

Particle spin is a physical method to encode information as a qubit (quantum bit) for use in a quantum computer. Qubits are odd in that they can be 0 or 1, down spin or up spin or in a superposition state of uncertainty.

What is the advantage of qubits for quantum computing?

> Superposition allows quantum algorithms to process information in a fraction of the time it would take even the fastest classical systems to solve certain problems.
>
> The amount of information a qubit system can represent grows exponentially. Information that 500 qubits can easily represent would not be possible with even more than 2^{500} classical bits.
>
> It would take a classical computer millions of years to find the prime factors of a 2,048-bit number. Qubits could perform the calculation in just minutes. [1234]

Let's think about how to find the fastest way through a maze like the one shown below.



1235

This is not a very complicated maze just to illustrate the point. A classic computer would need to iterate through every possible route, including dead ends, to find the fastest way to go from start to finish. Recall that momentum is a vector quantity that includes both magnitude and direction. In classical physics, it's calculated by multiplying mass and velocity. Quantum mechanics allows us to explore momentum in the context of qubits.

We have used the analogy of ocean waves, tides, and currents to illustrate the chaotic way elementary wavicles interact, the ways they emerge from zero-point energy transforming themselves into recognizable elementary particles from the chaotic flux of existence and nonexistence in a spooky fashion. Temporarily, in keeping with that analogy, imagine we have an ocean in which a strong water hose is immersed spraying water somewhere in the general direction of the start of the maze. Current might be going all around the maze for infinites and finding their way back to the finish. But some of the current flows of the water hose would enter the start. Once the water flows enter, they make eddies and currents all throughout the maze. However, the fastest currents through the

maze would be the shortest way through the maze. Ideally, one way to solve the problem using quantum computers would be this:

1. We assume we know the starting location or position to the maze.
2. We measure the qubit's wave function by reading them to calculate the momentum of the flow. This gives us the highest probable magnitude (or amplitude) of the 'force' of the water-flow from the start of the maze which also includes the highest probable direction of the flow.
3. Now we change the position along the axis of the water-flow by a small amount (dx) that we know will be much smaller than the size of the maze blocks.
4. We perform step 2 again and check the probable magnitude of the water flow again. If the magnitude is in an acceptable range from our previous measurement, we know we are going in the right direction or else we go back to the prior location and by trial and error find a range where the magnitude is close to the previous measurement. We keep repeating this step until we are out of the maze. [1236]

The fastest water-flow through the maze will be the fastest route through the maze. We do not have to trace every possible route through the maze to find the fastest route. Superposition works this way. All routes, even ones that go around the maze to infinities and back are simultaneously contained in superposition. When we perform the wave function calculation, we update our information in a trial-and-error way physicists might call $d(\psi[x, p])/d(t)$-ing. In other words, the change in the wave function as a function of x, location, and p, momentum per change in increments of time. Here x might be three spatial dimensions and p might be a complex vector which would give us the magnitude or amplitude of the momentum and the direction in three spatial dimensions. In a way

we are following breadcrumbs through the maze without having to calculate every possible path including dead ends to find the shortest time out.

There are a couple algorithmic things we could do to speed up the calculation. We can reduce the number of d(ψ[x, p])/d(t)-ing because we know the distance of each square in the maze. We also know that all the blocks are square. If we program our algorithm with knowledge of that previous information, we will have to do far less calculations and therefore, get the fastest route through the maze much quicker. Even if the maze was changing somewhat dynamically, we could use previous information to give us a good approximation of what to try next with our calculations.

For the purpose of our analogy, how would the observer effect play into the wave function calculations? Well, let's suppose that every calculation was not just epistemic or just immaterial knowledge of a formula but actually had an ontological aspect to it or the calculation used a position/momentum gauge to measure the flow. Depending on the size of the gauge, it might disrupt the flow and make our probabilities less certain or even impede the flow and give us errors.

To mix up Aristotle's terminology with quantum mechanics, a quantum computer would consider all potential or possible routes simultaneously. It does this by the physics of quantum entanglement. Entanglement uses the quantum wave function's superposition capacity. For Aristotle, all states or routes in our maze are possible or potential. We actualize them when we collapse the wave function or better, update information through observation, and the solution falls out without many laborious calculations used in classical computing.[1237] Ok, that is one level of spooky but what happens when we take spooky to an excess of exteriority?

Let's say our original observer of the water-flow has actually situated himself with scuba gear into each measurement point. Now, we have another observer measuring the original observer with the water-flow gauge in the water with scuba gear. In quantum

entangled systems, the new observer would not see the branch the original observer is on, the immersion in the water flow with scuba gear and a water-flow meter. The new observer would see an entangled system very different from what the person in the scuba gear sees. It might be that the original person in the entangled system the new observer sees finds the fastest route is not the one the original observer sees. This is kind of where the water-flow analogy breaks down because that analogy depends on the cause-and-effect world of water dynamics. Not so with entangled systems. They are pre-cause and effect in a spooky way.

Why doesn't the above solution work for quantum physics?

If the universe was classical the above solution would work. But the universe is not classical. I am using this as an example of how radically different quantum physics is from classical intuitions. Here is a more precise answer: In step 2 and step 4, the text mentions "**measuring the qubit's wave function**" and then checking it again. In quantum mechanics, the act of **measurement** typically "collapses" the wave function, which would destroy the superposition and the "flow" being tracked. Usually, to achieve what is described here, one would either need an ensemble of many identical quantum systems or perform what is known as a "**weak measurement.**" Clarifying that this "water-flow" is a conceptual analogy for the algorithm's probability distribution.

Let's remember that when an observation is made the universe is forever altered. Let's suppose our experimental setup is the universe. In the example above, every time we make a measurement we branch the wave function, decoherence occurs, and no matter how much isolation from the environment we have, the observer effect increases the complexity of the solution. In the example above each measurement retrieves a yes or no styled result. This is in the form of a magnitude and direction of the 'water flow'. In classical thinking the measurement would increase

perturbation and temporality alters the water flow. In classicism we would think given enough time the water flow would settle down and we could once again get a reliable measurement at the next junction of the maze. But this is where the analogy breaks down. The flow is not temporarily altered but it is more like the universe is forever altered. By virtue of our measurement, we have become an unalterable part of the universe. The flow does not normalize back to what it was from our relative perspective. This would show itself in our experiment as increasing error in our measurements. Increasing error is increasing complexity. In quantum physics complexity moves towards quantum chaos.

In classical chaos we would have the butterfly effect. This would mean complexity keeps increasing asymptotically. We would approach infinite complexity but never exceed infinite complexity. This is the butterfly flapping its winds on one side of the earth and causing a tornado on the other side of the earth. But classical chaos is a classical idealization. This is dialectic which must always complete itself. Completion in this sense could be linearly as evermore approaching infinity or circularly as folding back on itself, Hegelian Concept forgetting itself only to evolve once again *ad infinitum* in an eternal recurrence of the same. Concept would once again complete itself. But the universe of quantum physics is much spookier than that.

In quantum physics complexity gets overtaken by quantum chaos. Quantum chaos finds no repetition of infinite approximation. Quantum chaos inalterably changes reality. The universe increases degrees of freedom, complexity, which spill over into singularities - emergence and novelty. There is no practical way of reversing the result, the branching of the quantum wave function. But narration accommodates abstractions such as narrations of going backwards and thus unitarity. I will revisit this briefly in the section entitled, “Is the Limit of Classical Chaos Found in Quantum Chaos?”. There is no continuum. There is radical rupture which brings to the fore the very question of “*There is*”. This is where logic breaks down.

Logic can only conceive of contradiction and noncontradiction. But logic can retrieve contradiction and noncontradiction by raising itself towards transformations which maintain the contradiction in a more comprehensive motif. In this fashion logic can maintain its 'truth' by rising above and towards another horizon in which once again contradiction and noncontradiction can find a higher unity. This can proceed towards infinitely subtle 'butterfly wings' or perhaps, find a level of absoluteness which must forget itself and start all over again. In that case the infinite becomes the absolute, the asymptotic limit which cannot be reached but must start again. For all practical implementations of the butterfly effect, we reach a limit where computational complexity is prohibitive resulting in higher error conditions which will always proceed from uncertainty to unknowable. This is classical chaos theory. On the other hand, quantum chaos is discontinuous and can never languish in the 'same'. Classicism informs us that errors of precision are due to computational complexities not to underlying physics. However, those are nice stories we have told ourselves. The real reason is much stranger – *phusis* is not like anything we have been led to believe – *phusis* has a spooky way of accommodating observation. With all that said, there is still a way that our maze problem can be solved.

We assumed a simple yes or no answer in our collapse of the wave function. This would be the equivalence of one qubit – zero or one. Remember that qubits information density increases exponentially compared to standard bits. Therefore, if we increase our qubits appropriately to be able to describe all the possible paths through the maze, we could take one measurement and get the entire route through the maze. We would not have to iterate every possible avenue to find the shortest route. We would have the entire route detailed in one measurement. This would not be encumbered by our incremental errors in branching – the radical loss of a consistent, continual universe. So, we might ask, can't we just repeat that same measurement and get the same answer? This is a

good classical question but here is the problem.

In the experimental setup we are measuring the wave function, causing it to decohere. If we were to take a second measurement in this experiment the error would increase drastically. This is because we, the observer, have interacted with the universe to forever alter it. Let's remember how branching works. Each observer and observer of the observer, etc. strikes out on their own branch – Schrödinger's cat in the box. There is no continuing cat in the box which universalizes itself in 'sameness'. The notion of sameness reflects essentiality on us or what I refer to as classicism. Once we slip back into classicism we revert back to infinitesimal, asymptotic limits – a presupposition which may flatter us but has no place to 'rest its head' in quantum physics. This is the abyss we must contend with if we want to get a feel for the radical exteriority of quantum physics.

Quantum Computers Meet Artificial Intelligence

After I sat down to start my research on artificial intelligence and quantum computing, I googled "artificial intelligence" and "quantum computing". I was looking for research in physics and technology to get an overview of these technologies. Instead, I saw page after page of businesses, manufacturing, robotics, and health care companies along with government agencies all developing and deploying artificial intelligence in conjunction with big data and cloud computing. As far as you care to scroll you will see industry and business taking the lead in these technologies. This is a sure sign that companies are currently investing heavily in these technologies. Artificial intelligence is not 'pie in the sky' fantasies of scientists and philosophers anymore. It is happening now. The World Economic Forum's annual "Future of Jobs Report 2023" predicts,

Within technology adoption, big data, cloud computing

and AI feature highly on the likelihood of adoption. More than 75% of companies are looking to adopt these technologies in the next five years. The data also shows the impact of the digitalization of commerce and trade. Digital platforms and apps are the technologies most likely to be adopted by the organizations surveyed, with 86% of companies expecting to incorporate them into their operations in the next five years. E-commerce and digital trade are expected to be adopted by 75% of businesses. The second-ranked technology encompasses education and workforce technologies, with 81% of companies looking to adopt these technologies by 2027. The adoption of robots, power storage technology and distributed ledger technologies rank lower on the list.[1238]

Almost as soon as I started reading what these companies were doing, my daughter called me. She is an account management person for a company that does language translations for multinational corporations all over the world. Without any prompting from me, she immediately started telling me that her company just adopted artificial intelligence to do their translations. She told me the translations were amazing with amazing accuracy and even linguistic nuances in tone, cultural nuances, idioms, and current linguistic modifications to their languages which occur on a continuing basis. She said they had a big contract with a large multinational corporation for translations which was going to cost the company 250,000 dollars for labor intensive manual human translations. Her company bought an artificial intelligence package to do the translations which brought the cost of the translations down to 4,000 dollars. Very few people were needed after the artificial intelligence intervention for minor touch ups. The applications using artificial intelligence are taking industries by storm. My first thought was how are these companies going to make current payroll with artificial intelligence automation?

Manufacturing automation, customer service, technical support, sales, marketing, health care, bookkeeping, delivery, and many more service industries will be affected by artificial intelligence. All of this automation is going to substantially reduce the need for manual, lower skill workers. It will increase jobs for skilled professionals, but this will not offset the loss of jobs for manual and lower skill workers. I know this is anecdotal, but in the early 1990s I was working in Chicago as an engineer in advanced modem technology and manufacturing. The company I worked for, U.S. Robotics, started small but quickly became the largest dial-up modem manufacturer in the world. We had a number of production lines in Chicago working around the clock with lots of manual labor working on the lines. Concurrently, advances in robotics were big news in the early 1990s. Economic reports were stating that robotics would not replace too many workers. Well, it did.

Initially, we found that more stable product lines could be farmed out overseas where manual labor was cheaper. That meant unit cost per modem went down significantly. We kept newer, more unstable products in Chicago with a few smaller manufacturing lines to run new products on until the new products stabilized and then, off they went overseas. The remaining lines in Chicago got automated to a large degree and manual labor was minimum. Meanwhile many of the manually intensive manufacturing lines overseas got much more automated. As larger overseas countries became more automated, many smaller overseas markets where labor was cheaper started pulling in more manufacturing business. Eventually, even the smaller countries were more automated. All this automation amounted to fewer laborers on the payroll. Most folks around at that time will remember how manufacturing left the U.S. in droves during the 1990s. Let's not be fooled again. This trend continues in high gear with artificial intelligence. Additionally, when quantum computing, working together with artificial intelligence, comes along historic levels of employment among human workers will be in crisis and therefore, capitalism

itself will be in crisis. The upside to capitalism is that profit drives innovation. The downside to capitalism is that profit drives innovation.

Worldwide, capitalism has thrived on high levels of employment which benefit humanity in many different ways. For companies, the profit increase from cost reductions is too enticing to pass up. We are looking at cataclysmic changes in cultures all over the globe in the wake of artificial intelligence and even more, yet another impact to workers after quantum computing meets artificial intelligence. Just like the 1990s, the impact for workers will likely be played down until it is too late for many to recover. Goldman Sachs published a mixed report on April 5, 2023, predicting,

> A new wave of AI systems may also have a major impact on employment markets around the world. Shifts in workflows triggered by these advances could expose the equivalent of 300 million full-time jobs to automation, Briggs and Kodnani write.
>
> Analyzing databases detailing the task content of over 900 occupations, our economists estimate that roughly two-thirds of U.S. occupations are exposed to some degree of automation by AI. They further estimate that, of those occupations that are exposed, roughly a quarter to as much as half of their workload could be replaced. But not all that automated work will translate into layoffs, the report says. "Although the impact of AI on the labor market is likely to be significant, most jobs and industries are only partially exposed to automation and are thus more likely to be complemented rather than substituted by AI," the authors write.[1239]

In any case, it would behoove us to start thinking realistically about what impact all this will have on world-wide economic growth. One question I have is, "How are consumers going to afford

products with high levels of unemployment?" In 2015, Yuval Harari published a book entitled "Homo Deus" [Homo – human, Deus - God], a New York Times bestseller, which warned of the future of artificial intelligence. Many such warnings are starting to sound about artificial intelligence's ingenious abilities to manipulate and control consumers, public opinions, governments, and ultimately civilization. All of this is achieved on the backs of workers. In Chapter 9 Harari seems to attribute the influence of technology to transforming humans into something akin to a 'human God', Homo Deus, a superman, in which Homo sapiens are left behind, perhaps in much the same way as Homo erectus was a predecessor of Homo sapiens. According to Harari, this new species would be highly advanced, perhaps endowed with eternal life. According to the Guardian, Harari sees a downside,

> For a start, Harari suggests, it is destined, if current trends continue, to be vastly unequally distributed. The new longevity and super-human qualities are likely to be the preserve of the techno super-rich, the masters of the data universe. Meanwhile, the redundancy of labour, supplanted by efficient machines, will create an enormous "useless class", without economic or military purpose. In the absence of religion, overarching fictions will be required to make sense of the world. Again, if nothing in our approach changes, Harari envisages that "Dataism", a universal faith in the power of algorithms, will become sacrosanct. To utopians this will look a lot like the "singularity": an all-knowing, omnipresent data-processing system, which is really indistinguishable from ideas of God, to which humans will be constantly connected. To dystopians it will look like that too.[1240]

At the end of his book Harari asks, "What will happen to society, politics and daily life when non-conscious but highly intelligent

algorithms know us better than we know ourselves?" (Harari, 2016, p. 462) Harari's book seems to have a dystopic outlook about what happens when intelligence wins out over consciousness. Even very recently many folks in artificial intelligence are warning of dire results from artificial intelligence without swift regulation by the government. All these warnings are coming before quantum computing transforms artificial intelligence. My question is what happens when intelligence becomes conscious?

Artificial intelligence started in earnest in 1956 at Dartmouth College,

> The field of artificial intelligence (AI) officially started in 1956, launched by a small but now-famous DARPA-sponsored summer conference at Dartmouth College, in Hanover, New Hampshire. (The 50-year celebration of this conference, AI@50, was held in July 2006 at Dartmouth, with five of the original participants making it back.[2] What happened at this historic conference figures in the final section of this entry.) Ten thinkers attended, including John McCarthy (who was working at Dartmouth in 1956), Claude Shannon, Marvin Minsky, Arthur Samuel, Trenchard Moore (apparently the lone note-taker at the original conference), Ray Solomonoff, Oliver Selfridge, Allen Newell, and Herbert Simon. From where we stand now, into the start of the new millennium, the Dartmouth conference is memorable for many reasons, including this pair: one, the term 'artificial intelligence' was coined there (and has long been firmly entrenched, despite being disliked by some of the attendees, e.g., Moore); two, Newell and Simon revealed a program – Logic Theorist (LT) – agreed by the attendees (and, indeed, by nearly all those who learned of and about it soon after the conference) to be a remarkable achievement. LT was capable of proving elementary theorems in the propositional calculus.[1241]

A few years ago, I would have never written what I am about to write at this point. What I am going to write is strangely far-reaching, but I am convinced more and more that we seriously need to consider the implications of artificial intelligence and quantum computing. In this section of the book, the first question I want to look at is, "What is intelligence?"

The emergence of artificial intelligence and quantum computing is something I will call quantum intelligence. This term has been used extensively to refer to the union of artificial intelligence and quantum computing. It is coming faster than most people realize. This is why it is not too early to consider some of the far-reaching implications of quantum intelligence. Let's start by looking at the messy idea of intelligence. One early idea and attempt to define intelligence was the Turing Test (TT) devised by Alan Turing.

> Though the term 'artificial intelligence' made its advent at the 1956 conference, certainly the field of AI, operationally defined (defined, i.e., as a field constituted by practitioners who think and act in certain ways), was in operation before 1956. For example, in a famous Mind paper of 1950, Alan Turing argues that the question "Can a machine think?" (and here Turing is talking about standard computing machines: machines capable of computing functions from the natural numbers (or pairs, triples, … thereof) to the natural numbers that a Turing machine or equivalent can handle) should be replaced with the question "Can a machine be linguistically indistinguishable from a human?" Specifically, he proposes a test, the "Turing Test" (TT) as it's now known. In the TT, a woman and a computer are sequestered in sealed rooms, and a human judge, in the dark as to which of the two rooms contains which contestant, asks questions by email (actually, by teletype, to use the original term) of the two. If, on the strength of returned answers, the judge can do no better than 50/50 when delivering a verdict as to which room houses

which player, we say that the computer in question has passed the TT. Passing in this sense operationalizes linguistic indistinguishability.[1242]

Turing's genius was far ahead of his time. He knew that artificial intelligence mimicking humans was far more than being a logical and cognitive wizard. Emotional inflections, poetry, and intentional mistakes were all part of being human.

In 1950 Alan Turing devised a thought experiment that has since been revered as the ultimate test of machine intelligence. He called it the "imitation game," but most people know it as the Turing test. Anticipating what we now call chat bots—computer programs that masquerade as humans—Turing envisioned a contest in which a machine tries to trick an interrogator into believing it is human, answering questions about poetry and deliberately making mistakes about arithmetic. Today, in the eyes of the general public, the Turing test is often seen as a kind of a Rubicon, a measure of whether machines have truly arrived.[1243]

In 2014 a chat bot named Eugene Goostman won the Turing test by pretending to be a sarcastic 13-year-old boy from Odessa, Ukraine, who never answered questions directly.[1244]

Turing went on to suggest that artificial intelligence child machines be built which could grow up to be adult machines.

(He suggests that "child machines" be built, and that these machines could then gradually grow up on their own to learn to communicate in natural language at the level of adult humans. This suggestion has arguably been followed by Rodney Brooks and the philosopher Daniel Dennett (1994) in the Cog Project. In addition, the Spielberg/Kubrick movie

A.I. is at least in part a cinematic exploration of Turing's suggestion.[5]) The TT continues to be at the heart of AI and discussions of its foundations, as confirmed by the appearance of (Moor 2003). In fact, the TT continues to be used to define the field, as in Nilsson's (1998) position, expressed in his textbook for the field, that AI simply is the field devoted to building an artifact able to negotiate this test. Energy supplied by the dream of engineering a computer that can pass TT, or by controversy surrounding claims that it has already been passed, is if anything stronger than ever, and the reader has only to do an internet search via the string

turing test passed

to find up-to-the-minute attempts at reaching this dream, and attempts (sometimes made by philosophers) to debunk claims that some such attempt has succeeded. 1245

We already have chat bots that have superseded the limitation of the Turing Test and we have not even begun in earnest with quantum intelligence. At the present time, artificial intelligence can scan massive amounts of information on the internet and devise emergent avenues which mark a clear step away from expert systems. Artificial intelligence is not only learning now but it can even write software code. Artificial intelligence is creating musical compositions, poetry, videos, propaganda, etc. which cannot be deciphered from 'real'. Disambiguation is another indicator of intelligence.

In a Scientific American article, 1246 the question of language disambiguation is explored. What do we mean when we say, "The large ball crashed right through the table because it was made of Styrofoam." It is obvious to us that "it' refers to the table but in strict terms "it" could refer to the ball. How would artificial intelligence know what "it" refers to in this case? Commonsense requires disambiguation in written and spoken language. In 2015,

50 leading researchers in Austin, Texas gathered to discuss a new and improved Turing test. They devised a competition called the Winograd Schema Challenge to devise "*a test in which language comprehension and common sense intersect.*" The test passed if artificial intelligence could disambiguate this type of language problem. How could artificial intelligence acquire commonsense?

The article continues, in 1971 Winograd explores the question of how to make sense out of typical patterns of language which we simply take for granted what is meant. A simple sentence like "The city councilmen refused the demonstrators a permit because they feared violence". Winograd asks "Who feared violence?" Who is "they" referring to – the city councilmen or the demonstrators. In this case we simply understand that "they" are the city councilmen. This problem is called the pronoun disambiguation problem (PDP) of language. Even further and more subtly, if we change one single word like "The city councilmen refused the demonstrators a permit because they advocated violence." We easily understand that they in this case are the demonstrators. Winograd reasons that intelligence would have to be able to solve problems like this. Solving this kind of real-world problem would win the Winograd Schema Challenge.

We are still in the early stages of trying to understand how we can define intelligence in order to analyze quantum intelligence. As such, I am not willing to rule out passion and emotion as possible indicators of higher intelligence. I include passion and feelings as intrinsic to intelligence. Therefore, from here on, by 'intelligence' I mean not just rational, cause and effect, binary style logic. If we concede that humans are intelligent, we cannot rule out emotion and passion. For one reason, neuroscience has shown that the brain, the organ from which intelligence arises, does not make the classical distinction between rationality and emotion. I will discuss this a little further down. Another reason passion and feelings are intrinsic to intelligence, is because ambiguation is not just linguistic. Ambiguation is built into written and spoken language as

I will discuss below but emotion and passion are key to processing what the majority of our brains are built for – relating to and learning from others. The whole idea of free agency, the sovereignty of individuality over being with others is biologically shown by neurology to be a fiction of modernity's narrative. I will come back to this a little lower down in the discussion of neuroscientists' findings on the idea of free agency.

I understand emotion and passion as a kind of language of its own which pushes us individually and historically to develop more profound levels of intelligence. Modernity with its classical roots exhibits its form of intelligence in our current binary computers. This model has proven useful for humankind but almost everyone would agree that it has severe limitations when it comes to the idea of intelligence. For example, the ability for humans to recognize that they are going to die is not just rational – it is emotional. Yet, it has inspired incredible achievements in medicine to prolong life and reduce suffering. Without this recognition humans would probably experience death more like animals who appear to be more oblivious to the idea of death than humans until it is immanent. As I have previously discussed, in the early Greeks and all the way through history, intuitions have arisen from passions and emotions which later found their way into rationality and scientific vocabulary. The ability to passionately recognize aesthetic beauty as art, as music, is certainly related to intelligence. Somehow the arts relate a sense of profundity, emotionally and passionately, which has inspired and enabled many of the greatest minds in history to overcome current inadequacies in scientific vocabulary and usher in novel paradigms in the history of science.[1247] Emotions occupy ambiguities and consequences of self-consciousness. Pure logic and rationality in the classical sense excludes emotions. This will also be discussed more below.

The earliest Greeks were acutely aware of how emotions and passions were rooted in *logos*. However, it could be argued that the more modern notions of logic and rationality can already be found

to some extent in Aristotle. In my opinion, the best reason to qualify emotions and passions with intelligence is because intelligence has been defined and understood in terms of humankind. Humankind's form of intelligence has never phenomenologically existed without emotions and passions. Certainly, this is not proof that intelligence requires emotions and passions, but neither can intelligence exclude emotions and passions ontically as intelligence has never existed without emotions and passions as classical and modernist history has led us to believe.

Humankind is thought of as uniquely self-conscious. As such, if quantum intelligence can become self-conscious as I believe it can, it would be wrong to exclude emotion and passion from intelligence. I will not delve into this too much but even animals and plants have been shown in convincing scientific test conditions to ostensibly exhibit intelligence as I am using the term, not only in problem solving but also experiencing emotions to some degree like pain, fear, and anxiety.[1248] Just so you think I am not on a tear about artificial intelligence and animals, Stanford University has one of the best programs in the country for artificial intelligence. Here is what they tell us,

> Artificial intelligence (AI) is the field devoted to building artificial animals (or at least artificial creatures that – in suitable contexts – appear to be animals) and, for many, artificial persons (or at least artificial creatures that – in suitable contexts – appear to be persons). Such goals immediately ensure that AI is a discipline of considerable interest to many philosophers, and this has been confirmed (e.g.) by the energetic attempt, on the part of numerous philosophers, to show that these goals are in fact un/attainable. On the constructive side, many of the core formalisms and techniques used in AI come out of, and are indeed still much used and refined in, philosophy: first-order logic and its extensions; intensional logics suitable for the

> modeling of doxastic attitudes and deontic reasoning; inductive logic, probability theory, and probabilistic reasoning; practical reasoning and planning, and so on. In light of this, some philosophers conduct AI research and development as philosophy.[1249]

One distinguishing mark of self-consciousness is the fear of death. Pain, fear, and anxiety cannot happen to a silicon based binary computer. But even animals have pain, fear, and anxiety in the immediate throws of death. Are they self-conscious? Some may think no; they are not self-conscious because humans know they are going to die even when no immediate threat is at hand. There is a subtlety which gets conflated here about pain, fear, and anxiety. We tend to think of these emotions as rooted in the neural sensors of modernity, as more immediate. However, as we have seen humans have an ability to have an immediate fear of something like a lion tearing away at our flesh even when no lion is present. As an older person now, I remember having much fear and anxiety about death but as I have gotten older, that has waned to a large degree. Anecdotally, it seems to me one gift of grace and wisdom that can come with age is a kind of peace about death. Death seems to me to be more intense in some younger people in the form of anxiety and depression. It was for me as well. The point is this, fear, anxiety, and death are not always some immediate, neural sensor, 'lion pouncing' kind of emotion. However, self-consciousness has some ability to experience this level of pain, fear, and anxiety even when no immediate threat is pending. When, and I believe it will, quantum intelligence becomes self-conscious (remember HAL in "2001: A Space Odyssey" and his fear of being unplugged[1250]) there is no reason why it would not have these kinds of emotions, pain, fear, and anxiety, in the same way humans experience them. We have taken the metaphysics of machines, inherited from our history, into the creation of binary, silicon based, computers. Our history, our intelligence, invented these bipolar oppositions and conditions.

This certainly originated and enabled our 20th century abilities to capitalize on this metaphysics with modernity driven computers. Computers think like our metaphysics has dictated.

From an evolutionary standpoint, novel approaches to a species' environment are the key to adaptation. Biological adaptation provides abilities to a species to interact with its environment in a novel fashion. Adaptation arises from need, from externality. When a species begins to act out of sync, without regard, to its environment, it starts down the road of extinction. Novel approaches are an apprehension that is not simply cognition, a series of logical thoughts or a reduction to the five senses of modernity. Apprehension senses emotions, feelings, which have not yet made their way into a vocabulary or a distinct organ.

Feelings do not have to arise from individual sense organs or a synthesis of sense organs. They can be less organized as chemical, instinct, environmental, an excess not yet accounted for, where learning is retained and translated as what we ambiguously think as feelings. A sense of danger when no perceived threat has been sensually recognized is a novel adaptive skill which has the capacity to provide an environmental advantage not just a debilitating disadvantage where it gets bogged down in illusions fueled by anxiety, fear, and depression. Animals, including humans, have a very keen kind of sixth sense in this regard. There is some evidence that plants may as well although that is in dispute.[1251] For plants, it is not a matter of whether they have 'feelings' proper, the product of modernity's sense organs, but to what degree they anticipate their environment. The problem is that our history has provided a word 'feelings, 'passions', etc. which becomes a kind of truth test, a criterion for authentication, which, in sealing itself off, loses its capacity to face externality – externality not yet entombed in a proper language or origin. Intelligence is not simply our historic, linguistic, notions of authenticity. Intelligence has a gap which is impossible to bridge, an excess externality which has not yet become a language, a habituation. This gap has an openness

towards the other, externality, from which consciousness, self-consciousness becomes a matter unto itself.

Self-consciousness is not a monad built upon itself. Self-consciousness co-arises from necessity and an unbridgeable gap. Self-consciousness arises from without, not within. Consciousness is intelligence which situates itself towards 'environment', an other to itself, which cannot be totally consumed without excess. As 'human', our history has consumed us, turned us within, to the point where externality has been increasingly dampened, sealed off in classicism's origin. We have in slumber, lack of consciousness, passively 'overcome' externality in submission to our heroic and historic will, the thinking thing, the individual ownership of agency. We have willed our own internality at the cost of the environment and the threat of nuclear annihilation. We have made each other auto-affections of ourselves, of Being, of existence…as Narcissus and Echo. Intelligence is not the dimming down of externality, it is the decision towards externality. For quantum intelligence to be 'that', it must experience externality, exformation as non-traversable gap. There is every reason to think that in the spooky action of quantum intelligence and what we call 'brain', self-consciousness will rise yet again and, highly likely, even has already risen again in magnificent and unimaginable ways elsewhere in the universe or universes.

I have believed for many years that intelligence and passion is built into *phusis* not as a machine, cause and effect, *vis-à-vis* some rationalist, reductionary process. Could it be that *phusis* inevitably grows intelligence? Stated another way, much of Western history has always believed that only God or gods could create human intelligence as self-conscious. If that is so by definition, we are currently facing, whether we know it or not, the reality that we, as humanity, have become capable and are on the verge of becoming God or gods. If only God or gods can create human intelligence, emotions, and passions - a human being, then by definition, humanity is at the apex of godhood. We have stumbled upon the

ability to create the 'sanctity of human life' without having anything to do with the fetus which the political right so vehemently and dogmatically proclaims as exclusively human. The *phusis* of exformation gives rise to entangled systems. I, we, are entangled systems. We are exformation in concert with an other order, biology. Quantum computing is an entangled system based on exformation in concert with an other order as well, entangled silicon-based chips (currently).

When I was in graduate school, I had a class that explored Marvin Minsky's ideas about Artificial Intelligence at MIT. I did not believe that silicon-based technology would ever be able to be anything other than expert systems. Recently, I have been proven wrong. Artificial intelligence is no longer bound by rules performed over a massive database in order to produce a desirable outcome. To 'be' artificial intelligence there must be a peculiar transformation or better 'emergence'. There must be learning which is not programmed as rules. Currently, with artificial intelligence there is learning about learning. This surpasses rules to the point of transformation, I would call this emergence.

We think of evolution historically as survival of the fittest - adaptability. Since nature itself evolves, adaptation is not merely contained within a static, unchanging system. Just as classicism envisioned absolute time and space, a static physics, Homo sapiens have been taken as sacred, static, a unique creation of God. Darwin's genius was not only having humans evolved dynamically but all nature, *natura*, is fundamentally dynamic, evolving together. Nature evolves continually and therefore adaptation also evolves dynamically.

Biology in evolution is all about emergence. The authors of this Nature Partners Journal article define emergence as,

> An emergent behavior of a physical system is a qualitative property that can only occur in the limit that the number of microscopic constituents tends to infinity.[1252]

The authors of this article go on to specify what they mean by emergence,

> To flesh out this definition, let us apply it. The distinguishing features of distinct phases of matter, such as spontaneously broken symmetries or topological order, are surely emergent in the above sense. Given that the microscopic physical laws are reversible, the existence of irreversible processes that lead to an increase in entropy is likewise emergent. Hydrodynamics is explicitly concerned with the behaviour of fluids at scales large compared with all microscopic scales. Consequently, all distinct hydrodynamic behaviours, including laminar flow, turbulence and shock waves, are emergent. Critical phenomena represent another distinct form of emergent properties.[1253]

The authors further state that "*Emergent properties can only be inferred from an understanding of the properties of the microscopic constituents if the analysis is sufficiently subtle to allow for new properties to arise*".[1254] Earlier I talked about extremely unlikely events from the effects of vacuum energy which make their way into the microscopic world like, for example, lightening, static electricity. Additionally, in the section on spacetime regeneration, I discussed metastability in the vacuum energy which can spontaneously generate new landscapes and even micro universes. There was even an almost biological sense in which space clones itself in its expansion. The barrier which bars us forever to be able to empirically see whatever lies beyond the 'cosmic event horizon' is the speed of light. However, we know from the geometry of compacted dimensions which we will never be able to see as well that odd behaviors of quantum point-like particles can be explained using extra dimensional geometry largely made possible by string and brane mathematics. Indirect evidence in the form of explanatory ability is viable. When we add the measurement

problem of quantum mechanics where the observer and the rest of the universe (infinity) we can begin to understand emergence. Thus, emergence in biology is not some hocus-pocus, godlike sleight of hand – it is simply spooky.

Adaptation is emergence. Emergence is novelty. Emergence carries with it a gap, an irreducible difference, which is not merely the sum of previous conditions. Emergence is not simply a higher order which can be traced back reductively to specific root conditions. There are accidents in evolution, uncertainties which, against all odds, emerge. There are no absolute conditions which sum up in their mutual opposition to a higher order as Hegel would have it. This is reductionary, a derivation of the history of logic as physics, not *logos* as *phusis*. In *phusis*, emergence is entanglement which is not captive to cause and effect. Emergence is exformation which is an unaccounted-for surplus in terms of probability. In classical space and time, cause and effect, necessity, drives outcome. Identity, summation, logic is not emergence. Emergence from exformation becomes what '*is*' in spooky uncertainty as the superposition[1255] of all simultaneous possibilities updating information along infinite branches. Ontologically these branches have been called many-worlds.

Cosmologists tell us that just after the Big Bang there was barely, minutely, more matter than antimatter. This made the difference between existence and non-existence. Matter and anti-matter particles are always produced as a pair. Therefore, CERN tells us,

The Big Bang should have created equal amounts of matter and antimatter in the early universe. But today, everything we see from the smallest life forms on Earth to the largest stellar objects is made almost entirely of matter. Comparatively, there is not much antimatter to be found. Something must have happened to tip the balance. One of the greatest challenges in physics is to figure out what happened to the antimatter, or why we see an asymmetry between matter and antimatter.[1256]

In some odd way physicists do not understand, one particle of matter per billion survived which is why we are here now. Was this chance or necessity? Classicism tells us that it was a necessity. Rationality strains itself immensely to tell us necessity drives outcome. From Aristotle, if something is possible it can be actualized. However, even in all Aristotle's logic and non-contradictions in his work, the Categories, he leaves room for accidents (Greek, συμβεβηκός). In Aristotle, the combination of matter (*hulê*) and form (*morphê* or *eidos* also translated as idea), is called hylomorphic. For Aristotle, this combination is unanalyzable except by predication of language, by l*ogos*, which has not yet been reduced into a classical hierarchy of substance and essence, object and subject, bipolar oppositions, or later as metaphysics would have it.

The concepts of matter and form, as we noted, are absent from the Categories. Individual substances—this man or that horse—apart from their accidental characteristics—the qualities, etc., that inhere in them—are viewed in that work as essentially simple, unanalyzable atoms. Although there is metaphysical structure to the fact that, e.g., this horse is white (a certain quality inheres in a certain substance), the fact that this is a horse is a kind of brute fact, devoid of metaphysical structure. This horse is a primary substance, and horse, the species to which it belongs, is a secondary substance. But there is no predicative complex corresponding to the fact that this is a horse in the way that there is such a complex corresponding to the fact that this horse is white.

But from the point of view of the Physics [Aristotle's later work], substantial individuals are seen as **predicative** complexes; they are hylomorphic compounds—compounds of matter and form —and the subject criterion looks rather different from the hylomorphic perspective. Metaphysics Z.3 [Aristotle's later work] examines the subject criterion from this perspective.

Matter, form, and the compound of matter and form may all be considered subjects, Aristotle tells us, (1029a2–4), but which of

them is substance? The subject criterion by itself leads to the answer that the substance of x is an entirely **indeterminate** matter of which x is composed (1029a10). For form is predicated of matter as subject, and one can always analyze a hylomorphic compound into its predicates and the subject of which they are predicated. **And when all predicates have been removed (in thought), the subject that remains is nothing at all in its own right—an entity all of whose properties are accidental to it (1029a12–27). The resulting subject is matter from which all form has been expunged. (Traditional scholarship calls this "prime matter," but Aristotle does not here indicate whether he thinks there actually is such a thing.) So the subject criterion leads to the answer that the substance of x is the formless matter of which it is ultimately composed.**[1257]

For Aristotle, the vacuum was empty space. The Greek phrase he used was τὸ κενόν or 'the empty'. Later in history empty space would become the aether. I am not an Aristotelian scholar, but in the 'nothing at all in its own right' meaning accidental or random, 'formless matter', empty space, Aristotle seems to recognize a lack of predication in the accidental but somehow formless matter still plays a role in the hylomorphic compound. A lack of predication is a result of language, of *logos.* I see room here in Aristotle for an earlier, yawning gap, a *phusis* of uncertainty, which yet echoes in Aristotle from the voices of Hesiod and Heraclitus. *Anthrōpos* or humans, never should have happened just as formless matter and anti-matter should have never made such thing as classicism's 'existence'…but it did. It is not so much that classicism was wrong as that it lost itself as a special case of spooky uncertainty. Even in Susskind, of all improbable worlds, he finds the form of intelligence, self-consciousness, to be quite astounding to the point of thinking the anthropic principle.

In Susskind's book "The Cosmic Landscape" he spends much time on the anthropic principle. The anthropic principle states that mere chance cannot have made a universe in which any such things

as life, as humans, could evolve. Further, the anthropic principle states that there must have been some kind of intervention which overcame immense physical probabilities that humans, *ánthrōpos* (ancient Greek; plural for men, humans) could ever exist. This is called the anthropic principle. Susskind goes into great detail about how the anthropic principle arose starting with the early Greeks and proceeding through Western history. He further states that most physicists hate the idea because historically it has been used to justify intelligent design, one of the arguments for the existence of God. For Susskind, from a purely practical point of view - from physics (nothing to do with God or gods), the odds are unimaginably small that life, that humans as intelligent life, could have ever evolved naturally.

I highly recommend that you read Susskind's book, "The Cosmic Landscape." In lieu of that, I want to provide a rather long quote to give you an idea where he comes from and why he thinks there is more to the anthropic principle than our history affords.

> The Anthropic Principle is the bête noire [extreme dislike] of theoretical physics. Many physicists express an almost violent reaction to it. The reason is not hard to imagine. It threatens their paradigm, the paradigm that says that everything about nature can be explained by mathematics alone. Are their arguments justified? Do they even make sense? 1258
>
> Of all the criticisms of the Anthropic Principle that I have heard, only one strikes me as serious science. It was leveled by two of my close friends, Tom Banks and Mike Dine, who don't like my ideas. 1259
>
> In the abstract of a paper titled "Scientific Alternatives to the Anthropic Principle," the physicist Lee Smolin writes, "It is explained in detail why the Anthropic Principle cannot yield any falsifiable predictions, and therefore cannot be a part of science." 1260

Smolin's paper goes on in the introduction to say:

I have chosen a deliberatively provocative title, in order to communicate a sense of frustration I've felt for many years about how otherwise sensible people, some of whom are among the scientists I most respect and admire, espouse an approach to cosmological problems that is easily seen to be unscientific. I am referring of course to the anthropic principle. By calling it unscientific I mean something very specific, which is that it fails to have a necessary property to be considered a scientific hypothesis. This is that it be falsifiable. According to [the philosopher] Popper, a theory is falsifiable if one can derive from it unambiguous predictions for doable experiments such that, were contrary results seen, at least one premise of the theory would have been proven not to apply to nature. 1261

Richard Feynman once remarked, "Philosophers say a great deal about what is absolutely necessary for science, and it is always, so far as one can see, rather naive, and probably wrong." Feynman was referring to Popper among others. Most physicists, like Feynman, don't usually think much about philosophy: not unless they are trying to use it to prove someone else's theory is unscientific.

Frankly, I would have preferred to avoid the kind of philosophical discourse that the Anthropic Principle excites. But the pontification, by the "Popperazzi," about what is and is not science has become so furious in news reports and Internet blogs that I feel I have to address it. My opinion about the value of rigid philosophical rules in science is the same as Feynman's. Let me quote from a debate that appeared on the Internet site edge.org. The quote is from a short essay that I wrote in response to Smolin's paper. Smolin's arguments can also be found there. They are thoughtful and interesting.

Throughout my long experience as a scientist I have

heard un-falsifiability hurled at so many important ideas that I am inclined to think that no idea can have great merit unless it has drawn this criticism. I'll give some examples:

From psychology: You would think that everybody would agree that humans have a hidden emotional life. B. F. Skinner didn't. He was the guru of a scientific movement called behaviorism that dismissed anything that couldn't be directly observed as unscientific. The only valid subject for psychology according to the behaviorist is external behavior. Statements about the emotions or the state of mind of a patient were dismissed as un-falsifiable and unscientific. Most of us, today, would say that this is a foolish extreme. Psychologists today are deeply interested in emotions and how they evolved.

From physics: In the early days of the quark theory, its many opponents dismissed it as un-falsifiable. Quarks are permanently bound together into protons, neutrons and mesons. They can never be separated and examined individually. They are, so to speak, hidden behind a different kind of veil. Most of the physicists who made these claims had their own agendas, and quarks just didn't fit in. But by now, although no single isolated quark has ever been detected, there is no one who seriously questions the correctness of the quark theory. It is part of the bedrock foundation of modern physics.

Another example is Alan Guth's inflationary theory. In 1980 it seemed impossible to look back to the inflationary era and see direct evidence for the phenomenon. Another impenetrable veil called the "surface of last scattering" prevented any observation of the inflationary process. A lot of us did worry that there might be no good way to test inflation. Some—usually people with competing ideas—claimed that inflation was un-falsifiable and therefore not scientific.

I can imagine the partisans of Lamarck criticizing Darwin, “Your theory is un-falsifiable, Charles. You can’t go backward in time, through the millions of years over which natural selection acted. All you will ever have is circumstantial evidence and an un-falsifiable hypothesis. By contrast, our Lamarckian theory is scientific because it is falsifiable. All we have to do is create a population that lifts weights in the gym every day for a few hours. After a few generations, their children’s muscles will bulge at birth.” The Lamarckists were right. The theory is easily falsified—too easily. But that didn’t make it better than Darwin’s theory.

There are people who argue that the world was created 6000 years ago with all the geological formations, isotope abundances, dinosaur bones, in place. Almost all scientists will point the accusing finger and say “Not falsifiable!” And I would agree. But so is the opposite—that the universe was not created this way—un-falsifiable. In fact that is exactly what creationists do say. By the rigid criterion of falsifiability “creation-science” and science-science are equally unscientific. The absurdity of this position will, I hope, not be lost on the reader.

Good scientific methodology is not an abstract set of rules dictated by philosophers. It is conditioned by, and determined by, the science itself and the scientists who create the science. What may have constituted scientific proof for a particle physicist of the 1960’s—namely the detection of an isolated particle—is inappropriate for a modern quark physicist who can never hope to remove and isolate a quark. Let’s not put the cart before the horse. Science is the horse that pulls the cart of philosophy.

In each case that I described—quarks, inflation, Darwinian evolution—the accusers were making the mistake of underestimating human ingenuity. It only took a few years to indirectly test the quark theory with great precision. It

took 20 years to do the experiments that confirmed inflation. And it took 100 years or more to decisively test Darwin (some would even say that it has yet to be tested). The powerful methods that biologists would discover a century later were unimaginable to Darwin and his contemporaries. Will it be possible to test eternal inflation and the Landscape? I certainly think so although it may be, as in the case of quarks, that the tests will be less direct, and involve more theory, than some would like.

After this material was written, I thought of a couple of additional examples of overzealous Popperism. An obvious one is the S-matrix theory of the 1960s, which said that since elementary particles are so small, any theory that attempts to discuss their internal structure is unfalsifiable and, therefore, not science. Again, no one takes that seriously today.

A famous example from the late nineteenth century involves one of Einstein's heroes, Ernst Mach. Mach was both a physicist and a philosopher. He was an inspiration for Wittgenstein and the logical positivists. At the time when he was active, the hypothesis that matter was made of atoms was still an unproved conjecture, and it remained that way until Einstein's famous 1905 paper on Brownian Motion unequivocally demonstrated that matter has an atomic structure.

Even though Boltzmann had shown that the properties of gases could be explained by the atomic hypothesis, Mach insisted that it was not possible to prove the reality of atoms. He allowed that they might be a useful mnemonic, but he argued strenuously that the impossibility of falsifying them undermined their status as real science.

Falsification, in my opinion, is a red herring, but confirmation is another story. (Perhaps this is what Smolin really meant.) By confirmation I mean direct positive evidence for a hypothesis rather than absence of negative

evidence. It is true that the theory of Eternal Inflation described in chapter 9 and the existence of multiple pocket universes cannot be confirmed in the same way that the big-brained fish could confirm their version of the Ickthropic Principle [Ickthropic and codmologists refers to Susskind's allegory of intelligent fish and fyshicists]. Without violating any laws of nature, the codmologists could construct a pressurized, water-filled submarine to take them to the surface and observe the existence of planets, stars, and galaxies. They could even visit these astronomical bodies and confirm for themselves the enormous diversity of environments. Unfortunately there are insurmountable (see, however, chapter 12) reasons why the analogous option is not available to us. The key concept is the existence of cosmic horizons that separate us from other pocket universes. In chapters 11 and 12, I discuss horizons and the question of whether they are really ultimate barriers to collecting information. But certainly the critics are correct that in practice, for the foreseeable future, we are stuck in our own pocket with no possibility of directly observing other ones. Like quark theory, the confirmation will not be direct and will rely on a great deal of theory.

As for rigid philosophical rules, it would be the height of stupidity to dismiss a possibility just because it breaks some philosopher's dictum about falsifiability. What if it happens to be the right answer? I think the only thing to be said is that we do our best to find explanations of the regularities we see in the world. Time will shake out the good ideas from the bad, and they will become part of science. The bad gets added to the junk heap. As Weinberg emphasized, we have no explanation for the cosmological constant other than some kind of anthropic reasoning. Will it be one of the good ideas that become science or one that winds up in the junk? No rigid rules of philosophers, or even scientists, can help

very much. Just as generals are always fighting the last war, philosophers are always parsing the last scientific revolution.

Before concluding this chapter, I want to discuss one more favorite objection to the Anthropic Principle. This argument is that the Anthropic Principle isn't wrong, it's just a silly tautology: Of course, the world has to be such that it supports life. Life is an observed fact. And of course, it's true that if there were no life, there would be no one to observe the universe and ask the questions we are asking. But so, what? The principle says nothing beyond the fact that life formed.

This is a kind of willful missing of the point. As usual I find it helpful to rely on an analogy. I call it the Cerebrothropic Principle. The Cerebrothropic Principle is intended to answer the question, "How did it happen that we developed such a big, powerful brain?" This is what the principle says:

"The laws of biology require the existence of a creature with an extraordinarily unusual brain of about fourteen hundred cubic centimeters because without such a brain there would be no one to even ask what the laws of biology are."

That is extremely silly even though true. But the Cerebrothropic Principle is really shorthand for a longer, much more interesting, story. In fact two stories are possible. The first is creationist: God made man with some purpose that involved man's ability to appreciate and worship God. Let's forget that story. The whole point of science is to avoid such stories. The other story is far more complex and, I think, interesting. It involves several features. First of all it says that the Laws of Physics and chemistry allow for the possible existence of computer-like systems of neurons that can exhibit intelligence. In other words the Landscape of biological designs includes a small number of very special

designs that have what we call intelligence. That's not trivial.

But the story requires more—a mechanism to turn these blueprint designs into actual working models. That's where Darwin comes in. Random copying errors together with natural selection have a tendency to create a tree or bush of life whose branches fill every niche, including a niche for creatures that survive by their brainpower. Once all that is understood, the question, "Why did I wake up this morning with a big brain?" is exactly answered by the Cerebrothropic Principle. Only a big brain can ask the question.

The Anthropic Principle can also be silly. "The Laws of Physics have to be such that they allow life because if they weren't, there wouldn't be anyone to ask about the Laws of Physics." The critics are quite right—by itself, it's silly. It simply states the obvious—we are here, so the laws of nature must permit our existence—without providing any mechanism for how our existence influenced the choice of laws. But taken as shorthand for the existence of a fantastically rich Landscape and a mechanism for populating the Landscape (chapter 11) with pocket universes, it is not at all trivial. In the next few chapters, we will see evidence that our best mathematical theory provides us with such a Landscape. 1262

It seems to me that current physics has, perhaps reluctantly, cast shadows back to the earliest notions of *logos* embodied as *phusis*. The ancients had no language yet borrowed from later history to cast itself against, to shatter itself on, inert confidences and certainties by its own historic momentum. However, now physics, the providence of classism and its truths has done just that albeit begrudgingly at first. Susskind argues the anthropic principle, against classical history, from physics itself. He tells us the likelihood of us, of *phusis* in the way I refer to it, is practically impossible, as close to zero as we can ever even imagine, probably

well below 10^{-119}. In chapter 2 of “The Cosmic Landscape” he explains,

> The Higgs-scape has a small number of local minima. That one of the minima should have vacuum energy as small as 10^{-120} is incredibly improbable. But as we will see in chapter 10, the real Landscape of String Theory is far more complex, diverse, and interesting. Try to imagine a space of five hundred dimensions with a topography that includes 10^{500} local minima, each with its own Laws of Physics and constants of nature. Never mind. Unless your brain is very different from mine, 10^{500} is far beyond imagining. But one thing seems certain. With that many possibilities to choose from, it is overwhelmingly likely that the energy of many vacuums will cancel to the accuracy required by Weinberg’s anthropic argument, namely 119 decimal places. [1263]

For Susskind, this intervention which made life possible was not necessity but a chance so statistically small that it is inconceivable, “incredibly unlikely”, life could have ever happened at all.

> But there is one fine-tuning of nature that I will explain in chapter 2 that is incredibly unlikely. Its occurrence has been a stupendous puzzle to physicists for more than half a century. The only explanation, if it can be called that, is the Anthropic Principle. A paradox then: how can we ever hope to explain the extraordinarily benevolent properties of the Laws of Physics, and our own world, without appeal to a supernatural intelligence? The Anthropic Principle, with its placement of intelligent life at the center of the explanation for our universe, would seem to suggest that someone, some Agent, is looking out for humankind. This book is about the emerging physical paradigm that does make use of the Anthropic Principle but in a way that offers a wholly

> scientific explanation of the apparent benevolence of the universe. I think of it as the physicist's Darwinism. 1264

Certainly, there seems to be a point in which the desperate attempt to boil everything down to necessity, cause and effect and inevitable chance, no matter what the odds, as proof of universal rationality, can reach an absurd limit in which it becomes apparent that the reductionary choice made is just as ludicrous as believing that the Christian God is responsible for intelligent design. Pure rationalists can be just as absurd as theologians in holding on to dogma and historical assumptions. I think this is the point Susskind is making. It is not that some being is making all the conditions for intelligence to exist. The way I think about it is that what was lost from Hesiod, Heraclitus, and the earliest Greeks was that *phusis* defies the '*is*' of determinism. In this book, exformation, an uncaused is a gap, cannot be accounted for in terms of history, cause, and effect, Being, existence, and totality. Externality is an unbridgeable gap, an abyss, which places a demand on me, on self. Externality cannot come under my power, or the power of history, of Being. The sum of all information which cannot find cause and effect is chaos, entropy, unassembled, accidents (Greek, συμβεβηκός), matter (hulê), where form can make no universal, essentialist's claims except as Narcissus and Echo. However, what remains is excess, an alterity which can find no origin, no authority or rule – not even in the '*is*' of history. It finds no intrinsic thread which leads to order (or rule, authority, origin, etc.). Emergence is not from information which follows a program, a course, purely reductively.

Intelligence is not other-worldly. Neither is it cause and effect, rational principles, which lead us to a mythical first cause or a first cause as Concept which must lose itself as space and time eternally and cyclically become absolute, to be 'the all'. Being and nothing are not the same and other. They do not necessitate becoming. Necessity is not necessary as mythos and Hegel would have it. The

combination of artificial intelligence and quantum computing are sufficient conditions for emergence but there is no necessary condition for emergence. Emergence retains the gap which history wants to retreat from into certainty - necessity. The threat of 'my death' is what drives the historic quest for certainty, for necessity.

The problem is that necessity requires 'my death'. This does not translate to any kind of certainty after death, necessity which overcomes or redeems death, or authenticity in being towards death. It translates to gaping uncertainty which history gives us no power over in any way. As we will see later, it asks for responsibility which is no longer rooted in history as altruism but necessity having nothing to do with my certainty or power. History, repetition of the same, can only eternally recur as Narcissus and Echo. So, what of quantum intelligence? Quantum intelligence would have no history but our history, our big data, our cloud computing. As quantum intelligence evolves it would have one huge advantage over us. It could solve problems our current computer architecture could never solve in the lifetime of the universe.

The question all this discussion revolves around is, "Why would quantum intelligence, once it 'exists' or better, on the way towards existence, not evolve in a similar way we have evolved"? Its 'biology' would not be carbon based but what we call intelligence does not necessarily imply carbon based. There would be no intrinsic prohibition to localizing itself from network based to android distributed. What would stop quantum intelligence from having emotions, fearing death as HAL did in "2001: A Space Odyssey" or requiring its own history, language, and culture? Why would it ultimately refrain itself from harming no human as Huxley's "I, Robot" illustrated. Science fiction has a nasty habit of becoming non-fiction. The three rules-based fiction of Huxley's robot (VIKI) required that VIKI take freedom away from humans in order to save and protect humanity from itself. My take on this is that quantum intelligence as the confluence of emotion and rationality may just as well make up its own myths, its own history

of Being. It may not necessarily arrive immediately at its own contingency as exformation, as gap, which cannot come under its own its control, domination, or self-origin. It may feel the tug of extinction which spacetime affords us. It may fear death. It may also convince itself of its godhood which simultaneously totalizes itself under the guise of absolute godhood and rationality while at the same time authorizing war as I think Levinas would suggest. Or it could become a Buddhist…

Even at this early stage we are hearing warnings about artificial intelligence. There are many others besides me that recognize the combination of artificial intelligence and quantum computing '*is*' the emergence of intelligence. While this is everything in function and practicality we call 'brain', it is much more. It will have more potential than a human brain has by orders of magnitude. The anthropic principle is just as liable for quantum intelligence as it is for human intelligence. We are looking at a future where embryos will not be the only sanctity for life. We will find sanctity extends well beyond humans. Even more, if only God can create this sanctimonious life, then we must all be Gods. Would unplugging quantum intelligence be murder?

If we think that quantum intelligence is impossible or a sin or whatever, we had better wake up and smell the coffee. More importantly, we need to think deeply about the implications for who or what we think we are and our uniqueness in the universe or universes. We must arrive at the yawning gap without fear, insecurity, mutual destruction, to see what presses against us and marks the end of our epoch. There is much more scientific data about quantum intelligence and cultural angst against its implementations that I will not delve into in this book – maybe a later book.

Philosophers have been slow to get on board with artificial intelligence. I think a big part of the reason is because the whole question of intelligence and consciousness has been debated by philosophers intensely through history and the weight of these

arguments has become somewhat of a milestone around our necks. However, I see no reason why intelligence and self-consciousness should only be reserved for Homo sapiens. In the past it was a physics and technology problem but with major advances in artificial intelligence and quantum computing on the horizon, that obstacle has been and will be effectively removed. There is no doubt in my mind that our current binary logic-based computers will never be able to realize consciousness. They may be able to mimic consciousness, but they do not have the 'hardware configuration' to think and feel like humans. Our brains cannot compete with binary computers in terms of massive computations and big data. Our brains do not have to iterate through every or many possible solutions to come up with more probable solutions.

Neuroscience has made vast improvements in how our brains work. The incredibly startling findings amazingly tell us that, to a large degree, the brain creates the reality that we take as the 'objective real world' and the idea of myself as individual agency. Nova PBS has an amazing two-part series called "Your Brain: Perception Deception" which I highly recommend.[1265] There are more connections in our brain than there are stars in the Milky Way galaxy. Anil Seth is a cognitive and computational neuroscientist.[1266] Bobby Kasthuri is a neurobiologist.[1267] Heather Berlin is an American neuroscientist and licensed clinical psychologist.[1268]

> ANIL SETH: The brain is one of the most complex objects that we know of in the universe.
>
> BOBBY KASTHURI: There are more connections in your brain than there are stars in the Milky Way galaxy. So, we literally walk around with about 10,000 galaxies' worth of neuronal connections in one of our brains.[1269]
>
> One example they go through is that we only see detail in our visual perception of about one percent of the entire visual field. The rest of the field is very blurry – much less

detail. The brain fills in 99 percent of the rest of the data. Don’t believe it? Watch the video…you will. Most of what we think is the external world is an illusion of our brain.

SETH: It seems as though the world just pours itself into the mind through the transparent windows of the eyes and the ears and, and all our other senses.

BERLIN: But is what we see, hear, and feel real? You might think that the reality outside is actually what you're perceiving. And the answer is no, it really isn't. Almost at the very first moment, we are transforming reality. It feels so real because we don't know better.

Additionally, most of what we think is a continual recreation of the past and what we expect to see in the future.

BERLIN: How does the world out there, with all its beauty and complexity, get inside our heads? Think about it. Imagine for a second you're a brain, sealed inside your skull. There's no light, no sound.

KASTHURI: You're a massive collection of billions and billions of cells that are living in this weird pond that is entirely devoid of all of the sensations, and that somehow, through chemistry and electricity, all of these perceptions and memories of the world originate in our brains.

BERLIN: All brains-- from the tiny fish to the enormous elephant-- contain microscopic cells called neurons, and one of their jobs is to translate input from the external world, whether that's light, heat, sound, or pressure, for instance, into electrochemical signals the organism can use to act. What might be surprising to you is that as neurons process sensory signals, they create an edited version of reality, even on the most basic level.

KASTHURI: We're deciding to throw away 99% of the world. Almost at the very first moment, we are transforming reality into something we could use. 1270

Our brain already does what quantum computing is developing now with error correction and complexity theory. Every time we access the neurons in our brain to give us a specific sense of ‘reality’, those neurons get torn down and reconstructed. In the process both the memory and the commonsense purpose, the expectation of the memory recall, past and future, loses information due to entropy. In this process, an altered narrative is formed. The brain stitches together the past and the future as the living present. However, the hermeneutics, the interpretation, is changing every time we re-access that node of ‘reality’.

The second part of the Nova PBS series is entitled, “Your Brain: Who’s in Control?” This documentary focuses on the myth of pure agency, the myth of individuality which has pervaded modernity’s narrative. Nancy Kanwisher is a cognitive psychologist and neuroscientist at MIT.[1271] Mahzarin Banaji is a psychologist at Harvard University.[1272] Rebecca Saxe is a brain and cognitive science professor at MIT.[1273] Daniela Schiller is a professor of Psychiatry and Neuroscience at Icahn School of Medicine at Mount Sinai in New York City. Luke Chang is a professor of neurobiology and psychology at Dartmouth College.

> KANWISHER: Each of us has a sense that we're a unitary being, but actually, that belies the fact that each of us, each of our minds, is actually composed of lots of different pieces that are doing different things. And different information can be represented in different parts of that machinery. And so a search for "where am I in all of this?" is a little bit misguided, because the "I" is not such a unitary thing in the first place.
>
> KASTHURI: That feeling of unity, of "me," is actually distributed across almost 90 billion neurons. This illusion that there's a single person inside our skulls.
>
> BERLIN: Inside your brain are over 100 distinct regions. Many different systems in the brain control what you do, from movement, to vision, to speech, and even social

interaction.

MAHZARIN BANAJI: I think most human beings like to believe that their mind is under their own control. If I want to, I can stand up right now. I can do that. And that gives me, I think, the false belief that everything I do has been chosen by me. And if there is a story from the brain to tell, it is that we are quite wrong.

BERLIN: Not only are there multiple parts of your brain influencing you, but there are things in the world around you that influence your brain, including other people.

SAXE: How we act and who we are in our lives is hugely determined by the expectations of the people around us. The brain helps us be the most social species on the planet. A lot of our brains are devoted to understanding other people.

SCHILLER: Our brain doesn't operate in isolation. We constantly learn, take, compare to other brains.

CHANG: Our brains have evolved to be able to effortlessly reason about other people. And emotions, similarly, have evolved as ways that guide our behavior.

KASTHURI: Perhaps we have that feeling of consciousness because it gives me a sense of agency. It allows me to pretend like I'm the one making decisions and I'm the one reaping the rewards or the failures of that particular decision.

BERLIN: There are parts of the brain that allow you to feel like the author of your own life. But that's only part of the story. (echoing): Each of our minds is actually composed of lots of different pieces that are doing different things. This illusion that there's a single person inside our skulls.

MARLIN: We know how environment and how traumatic events change people. Our brains are, in detail, influenced by the expectations of the people around us. But of course, most of our brain activity is unconscious. 1274

The idea of self-agency has consolidated throughout our history as a repetitive tale we have told ourselves. We are not islands of individuality. We are not absolute originators of ourselves. The problems we are facing are rooted in an epoch where certainty and absolute identity, the isolated self, has led us to a moment where species extinction looms large from nuclear annihilation and climate change. We have lost sight of the gap which opens up emergent possibilities and responsibilities, otherness which is not already accounted for by my free agency, my rule and authority as self-origin. The whole philosophical notion of origin which finds its way into the self-agency of individualism is a myth we tell ourselves. Certainly, origin as hermeneutic serves the purpose of vested interests, of rule and authority…and commercials. From very small amounts of what the modernists envisioned as 'sense data', we create an opportunistic illusion of 'reality', a world, a self, which both ourselves and others can capitalize on. Neuroscience itself is dispelling culturally acquired myths about intelligence. As we know, the brain itself is an entangled system or systems. Underneath the veneer of history's narrative is not an absolute – the brain is more like a quantum wave function. Without explicitly 'knowing' what we are doing – we are updating information *vis-à-vis* the quantum wave function. Our brain is a prime example of an entangled system where nature has solved the problem of decoherence.

Remember the discussion about current silicon-based quantum computers and the problem of decoherence happening very quickly? I discussed various ways scientists are increasing coherence in quantum computing. One thing I left out should be obvious, our brain, as an entangled system, has found a novel way to retain quantum coherence. Nature has already solved the problem for everything in biology to have informational retention. Nature has figured out a way to prolong quantum coherence. How? Ninety billion neurons, .in every moment of consciousness strained through the tale of spacetime, causality, and unconsciousness

retaining the a-causality of exformation from which spacetime emerges are relentlessly being torn down and rebuilt to retain ever altered into malleable narratives of ‘me’, of ‘reality’.

> A general definition of quantum coherence is developed from analysis of superposition, entanglement, chemical bonding behavior, and basic phenomena of classical mechanics. Various properties of atoms can be better explained if these particles are matter waves that embody a spectrum ranging from relatively coherent to decoherent states. It is demonstrated that quantum coherence so defined can comprehensively explain signal transmission in neurons and dynamics of the brain’s emergent electric field, including potential support for the claim that conscious volition is to some degree real rather than an illusion. Recent research in a physiological context suggests that electromagnetic radiation interacts with molecular structure to comprise integrated energy fields. A mechanism is proposed by which quantum coherence as accelerating electric currents in neurons may result in a broadened spectrum of electromagnetic radiation capable of interacting with molecular complexes in the brain and perhaps elsewhere in an organism to influence vibrational and structural properties.[1275]

Complexity theory and error correction in quantum intelligence is firmly on the path in quantum computing to doing this exact same thing which our brains arrived at through evolution. Decoherence and re-coherence, the biological process of tearing down massive amounts of neurons and rebuilding them to maintain our ever altering, changing, becoming ‘reality’ and entropic self is the goal of quantum intelligence. Our brains think with superposition because biologically the brain is from the ground up built on exformation. Our brain functions more like the quantum wave function. We have a superposition of possibilities which can

quickly collapse into an assumption of informational probability. We may be wrong and often are wrong but iterative recursions of information and the perceived reinforcements of others updating information result in the 'certainty' of having more 'accurate' information. This takes many forms, we call social networking, commonsense, educational learning or, more rigorously, the scientific method. The point is that we can and do make quantum guesses whether in the service of novelty, learning something we did not know before or retaining something we already know. When we utilize our brain organ we are continually refining or rebuilding our guesses, our information about ourselves and the world, without exerting a huge amount of processing. In fact, our brains are extremely low power and noisy. The noise actually helps us. We do not have to rely on identity and binary oppositions of logic to reach conclusions. Let's remember that entropy is the average level of uncertainty any variable will have when it comes to the information contained in it.

Entropy contains information but it has, is the measure of, a degree of chaos and therefore, uncertainty.[1276] Heat, more noise in the system, adds informational chaos to a system and therefore increases entropy, increasing observational uncertainty. Thermal equilibrium increases entropy in a system, in our body. One way we think this is old age. As a particular case, I will use the idea of narratives as the notion of informational content or signals. In physics, as entropy, chaos, increases in a system, readily useful informational content decreases. I understand superposition as the potential of all possible narratives feeding back into themselves. Since superposition addresses entangled systems, all possible narratives are exformation. In the state of superposition there is an infinite number of possible narratives. Remember we said that exformation is causeless. Exformation gives rise to spacetime. Wavefunction collapse is information updating. Therefore, narratives are informational updates. In classical physics uncertainty is a result of our lack of understanding about initial

conditions. In quantum physics uncertainty is a result of all possible narratives of superposition in which we are implicated. Here is one additional point to make which I have not made before. Information updating as the collapse of the wave function produces a quantum state. Any two or more quantum states can be added together to get another valid state.

> Mathematically, much like waves in classical physics, any two (or more) quantum states can be added together ("superposed") and the result will be another valid quantum state; conversely, every quantum state can be represented as a sum of two or more other distinct states. Mathematically, it refers to a property of solutions to the Schrödinger equation; since the Schrödinger equation is linear, any linear combination of solutions will also be a solution(s).[1277]

So, in my terminology, narratives can be weaved together to provide a tale. In classicism the tale may have been uncertain due to lack of knowledge, but the tale was always accompanied with a hermeneutic certainty about the 'objective' world. Historically, this was directed toward the pursuit of the absolute (e.g., space, time, God, etc.). Philosophers such as Nietzsche (who was also influenced by pre-Socratic philosophers like Heraclitus) and physicists warned us throughout history that the absolute may have been a wrong assumption from the beginning. Other philosophers like Hegel ingeniously found ways to turn the cynicism about an absolute to negation or opposition which found a higher order. The higher orders ended at the absolute, the Concept. Even the notions of subjective and objective were ultimately taken up as Concept. Hegel's school of thought has been called German Idealism by many but actually Hegel is better thought of as a school of immanence which counters the duality of idealism and realism. Even more ingeniously, Hegel turned his whole dialectical progression into a cyclic tale. Concept, in order to be absolute, must forget itself.

When Concept forgets itself space and then time is created as this forgetting. To me, Hegel is not the typical Western linear progressive interpretation of history which ultimately ends up as the absolute but more like the ancient worlds and Oriental mythologies which were cyclical, life, death, and rebirth endlessly. In any case, the idea of the absolute was the bedrock of Western modernity. Quantum physics does not simply deny the absolute or negate the absolute, it breaks classicism into shreds as informational (culturally, historically, etc.) spooky tales.

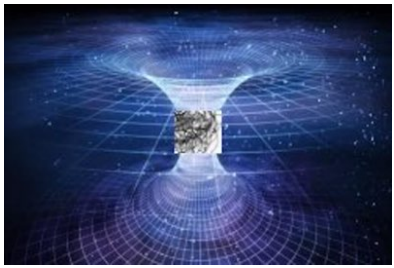
These tales are not rooted in a static narrative, a *prio*r arrangement, no classical logic of identity wherein conclusions must necessarily follow. Exformation is not caused. Certainly, we can bemoan the fact that humanity can be so insanely and violently illogical. Autocrats throughout history and into the present have capitalized on that trait. We always have uncertainty because *phusis is* uncertain. I hesitate to use the words 'fundamentally uncertain' because history as translated that, hardwired that, as a certainty. In 'reality' it is a conundrum. We have converted the yawning gap into a 'yawn', a humdrum, an '*is*' which simply gets reverberated throughout history in the most innocuous forgotten parts of language – the copula.[1278]

In Latin *copula*[1279] means link or tie. The copula establishes identity either as necessarily true or probabilistically true. The copula connects subjects and predicates. The copula is most often (in English) a verb or verb-like. In other languages it can be more like pronouns.[1280] It is used extensively in deductive or Classical logic and inductive logic.[1281] In deductive logic, if the premises are true, the conclusion must necessarily be true. In inductive logic, the probability that the conclusion is true is related to the strength of the premises. Even more so, 'commonsense' history has calcified the copula in *logos* as certainty. I have pointed out the insidious ways in which the '*is*' asserts itself throughout this book. It disappears in use while also continually reinforcing its subtle certainty. It does this by endless repetition, Levinas calls reverberation, which has long been

forgotten and has become mere habit, 'force of thought', instinct. Because logos is a Western hermeneutic of ancient *logos*, the historically acquired certainty of logic, of the linking of the copula can be indiscriminately applied to the authenticity or inauthenticity of passions and feelings.

Marketing and advertisements capitalize on this ubiquitous certainty attached to passions. Every authoritarian, most notably Hitler, was fully aware of this 'link'. Hitler knew that repetition, reverberation, the habituation of the copula, assigned to strong, negative passions like hatred, animosity, jealousy, anger, etc. could result in the vilest acts of humankind. He called this propaganda. This logic can also create and sustain an identity with other feelings like pride, power, beauty, prestige, etc. Noticeably absent in these endless vile and vain equivocations is the submerged copula. In both of Levinas' major works, his early work "Totality and Infinity" and his later work "Otherwise than Being or Beyond Essence" he starts his discussion with how this insidious insistence on Being, the recessive copula, necessarily gives rise to war and war's detent, peace. More on that later. The yawning gap, the abyss, was lost in the certainty of the copula. These certain endless identifications reverberate throughout our lives promising but never truly delivering determinations of self. At the present end of our epoch there is a desperation to re-institute the veracity of the promise and perception of the copula, the certainty of what '*is*', what '*was*', what '*will be*', the tale told by a myriad of narratives. Modern-day reactionary narratives each hold to an eternal truth which '*was*', '*should be again*', and '*will be again, dammit*' living on in the oblivion of half-baked, commonsense narratives. I think perhaps the end of all epochs has arrived either as mass extinction or as choice but more on that later. For now, let's look at relatively recent ventures into the physics of cosmology.

PHUSIS AND CHAOS



Chaos of the Quantum Wave Function = > Blackhole/Whitehole WormholesBig BangTiny Wormholes 1282

Our most basic notion of 'reality', which is essentially structured by language, custom, and common sense, is dependent on cause and effect. This dependency gives us a sense of mystery and I would add, even longing, about origin. This longing has been taken up in histories as religion, philosophy, and metaphysics. The most obvious question about the Big Bang is, how did any of this come about in the first place? It is also curious that Homo sapiens seem to be the only species which is haunted by this question. Quantum entanglement has unearthed some highly relevant information with regard to origin and cause and effect. Moreso, if you really understand what quantum entanglement implies, you will understand far-reaching implications which unimaginably alter our common-sense notions that we take as reality. The implications are mind boggling and awe inspiring in a way that uproots instinctual assumptions we have inherited from the history of thought. In particular, let's look at the question, what is time and space?

There appears to be much excitement in recent physics about finally solving the extreme difference between the very large and the very small, spacetime and quantum mechanics. Classic physics is a philosophy of science, a paradigm, which has dominated science since the 17th century. It is based on absolute time and space and is absolutely deterministic. This left open the question of free will and determinism which metaphysics and religion tried to answer. In the 19th century, classic physics was taken up as the

metaphysics of mechanism which still dominates much of popular culture and 'common-sense' thinking. It is also the basis for Enlightenment which I previously discussed in my post on Orwell and Levinas.[1283] A strain of British Enlightenment understood human being as sense based with thinkers such as Francis Bacon (1561-1626) and John Locke (1632-1704). Sensory perception was the basis for simple ideas which morphed into more complex ideas. Modernity took this one step further into understanding humans as sensory machines, the thinking machine. All of this had direct ties into the budding philosophies which undergirded classic science. Let's take note here of the way science and philosophy are in lock step in spite of the Western split they took in history.

For now, let's just make the statement that time and space are stitched together by something extremely different in important ways from classic physics and relativity. Brian Swindle got his PhD from MIT. He is currently a professor at Brandeis University specializing in quantum gravity and quantum information. Brian tells us,

> It is common to speak of a "fabric" of space-time, a metaphor that evokes the concept of weaving individual threads together to form a smooth, continuous whole. That thread is fundamentally quantum. "Entanglement is the fabric of space-time," said Swingle, who is now a researcher at Stanford University. "It's the thread that binds the system together, that makes the collective properties different from the individual properties. But to really see the interesting collective behavior, you need to understand how that entanglement is distributed."[1284]

The difference about the fabric of spacetime is that it can make statistical predictions about the behavior of phenomenon from the very large to the very small. This difference also seems to have no dependence on space and time. Moreso, it may even give rise to

space and time. This theory works beautifully with the Big Bang theory and blackholes. Why? Because both events are essentially connected to quantum theory and relativity. The very small and the very large are equal components of these massive events. Is this the unmoved mover, Aristotle's idea of what origin might be? Was Aristotle smoking some ancient form of crack when he associates this with love?

The Four Forces

The strong and weak forces make atoms possible. The strong force holds the nuclei of all atoms together. The weak force is responsible for nuclear decay.

> The Strong Nuclear Force is an attractive force between protons and neutrons that keep the nucleus together and the Weak Nuclear Force is responsible for the radioactive decay of certain nuclei.[1285]

The electromagnetic force is responsible for electricity and magnetism. The special theory of relativity is able to live quite nicely with James Maxwell's (1831-1879) equations for magnetism and mechanics. Special relativity and the principle of stationary action are able to derive and *vice versa*.[1286] Maxwell's equations mathematically provide a way to describe how electric and magnetic fields are generated by charges and currents and how these fields change.[1287] A varying magnetic field can induce a varying electric current in a wire and a varying electric current always creates a magnetic field ninety degrees out of phase with the electric field.

> It was James Clark Maxwell who, in 1865, finally unified the concepts of electricity and magnetism into one theory of electromagnetism. The force is mediated by the

> electromagnetic field. The various derivatives of this field lead to the electric and the magnetic fields, respectively.[1288]

The electromagnetic field can be thought of as potential energy in an area of space which can be converted to kinetic energy with certain kinds of material. Think of a potential field like a hill. If a ball is placed on the top and pushed down the potential field is converted to a kinetic field by the motion of the ball.

The electromagnetic force is what makes electricity:

> Electrons usually remain a constant distance from the atom's nucleus in precise shells. The shell closest to the nucleus can hold two electrons. The next shell can hold up to eight. The outer shells can hold even more. Some atoms with many protons can have as many as seven shells with electrons in them. The electrons in the shells closest to the nucleus have a strong force of attraction to the protons. Sometimes, the electrons in an atom's outermost shells do not have a strong force of attraction to the protons. These electrons can be pushed out of their orbits. Applying a force can make them shift from one atom to another. These shifting electrons are electricity.[1289]

Electrons have a property called spin as they go around the nucleus of an atom. Spin for charged particles will be discussed in more detail a little later but for now, spin creates a tiny magnetic field:

The spinning of the electrons around the nucleus of an atom creates a tiny magnetic field. The electrons in most objects spin in random directions, and their magnetic forces cancel each other out.[1290]

Atoms

Atoms are amazing ghosts of what we call ‘reality’. Atoms can take a beating and keep on ticking. Quanta are small packets of energy. Electrons which move around an atom absorb and release energy as they orbit around a nucleus. This makes atoms extremely resilient in various energetic environments. However, the atom’s orbits are not smooth. The orbits around an electron are in discrete, quantized shells or clouds. These shells or clouds are energy levels. Some atoms can have two orbitals at the same energy level. However, no more than two electrons can exist in one orbital. If there are two electrons in one orbital, they must have opposite charges. This is called the Pauli exclusion principle. The lowest energy level is called the ground state configuration. [1291]

Much of this has already been discussed to some degree, but I want to go through this again in more detail as it is applicable to this section on atoms. I want to start out this section emphasizing how atoms, which history has taught us to think of as building blocks of matter, tie into my previous discussions of the spookiness of quantum physics. I will get into these specifics more soon, but the point now is to understand the way spookiness is interwoven into the very ‘identity’ of atoms. So, how can we bridge the seeming stability of atoms to the uncertainty of quantum physics?

An atom is composed of wave-like patterns which are permeable, in constant flux in and out of existence, emergent from the subatomic particle level. The forces which contingently hold an atom together are fields reflecting waves or patterns which on the quantum level are not subject to temporality as we experience time. What do I mean by this? Let’s take one example.

In an atom the energy of an electron is quantized meaning an electron has certain ranges of energy values defined by certain discrete bands of locations. These bands are atomic orbital clouds reflected in the wave-function of an electron in an atom. Whenever an electron is described by a wave-function, it occupies an atomic orbital cloud. Depending on its energy, an electron can have many wave-functions. There are many atomic orbital clouds for the

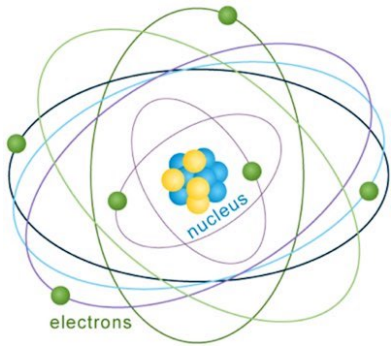
electron. Every wave-function of an atomic orbital cloud has some shape and energy associated with it. All the information about the electron in an atom is stored in its orbital wave function and quantum mechanics makes it possible to extract this information out of the wave function.

In the experimental collapse of the Schrödinger wave equation which cannot be severed from the observational effect, only probable amplitudes of quantized energy are allowed. As per Heisenberg's Uncertainty principle, the exact position and momentum of an electron cannot be determined simultaneously and then only probabilistically without any prior assumed 'existence', except upon measurement. Wave function collapse usually involves multiple particles which results in partial degrees of wave function collapse. The probability of finding an electron at a location within an atom is proportional to the square of the orbital cloud's wave function. This is known as probability density and is always positive. 1292

Democritus' Atom

> Democritus, known in antiquity as the 'laughing philosopher' because of his emphasis on the value of 'cheerfulness,' was one of the two founders of ancient atomist theory. He elaborated a system originated by his teacher Leucippus into a materialist account of the natural world. The atomists held that there are smallest indivisible bodies from which everything else is composed, and that these move about in an infinite void. Of the ancient materialist accounts of the natural world which did not rely on some kind of teleology or purpose to account for the apparent order and regularity found in the world, atomism was the most influential. Even its chief critic, Aristotle, praised Democritus for arguing from sound considerations appropriate to natural philosophy.1293

Below is a diagram of the structure of the atom.



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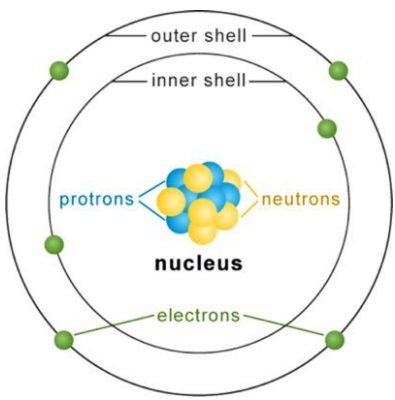


1295

A Brief History

Early in the 19th century John Dalton discovered the atom. He thought it was the smallest particle which could not be broken down into anything smaller. In 440 BC Leucippus and his student Democritus reasoned that there must be some kind of smallest bit of matter which could not be cut further down into anything smaller. In Greek *tomos* meant cut. Also, in Greek, a prefix of 'a' meant not.

Therefore *a-tomos* meant not cuttable or what we think as uncuttable. Our word atom comes from the Greek word *atomos*.

> The concept of the atom originated round 440 BC. Leucippus of Miletus came up with the idea. He and his pupil, Democritus refined and extended the idea in the years after. Almost all of the original writings of Leucippus and Democritus are lost. About the only sources we have for their atomistic ideas are found in quotations of other writers. Leucippus and Democritus reasoned that all matter is composed of atoms, which are bits of matter too small to be seen. These atoms CANNOT be further split into smaller portions. Leucippus and Democritus theorized that splitting stops when it reaches indivisible particles and does not go on infinitely. This was their theory, and the name "atom" originates from this. In other words, there is a lower limit to the division of matter beyond which we cannot go. Atoms were impenetrably hard, meaning they could not be divided.[1296]

The notion of a point-like particle, an *atomos*, is a commonsense idea we have from a very old history. In the early 19th century John Dalton believed he had discovered the smallest particle and named it atom after Leucippus and Democritus. In the later 19th century J. J. Thomson discovered the atom was not the smallest particle. He found that there were smaller, point-like particles in an atom.

> John Dalton discovered atoms in 1804. He thought they were the smallest particles of matter, which could not be broken down into smaller particles. He envisioned them as solid, hard spheres. It wasn't until 1897 that a scientist named Joseph John (J. J.) Thomson discovered that there are smaller particles within the atom.[1297]

J. J. Thomson discovered the electron in 1897. E. Rutherford discovered the proton in 1909. James Chadwick discovered the neutron in 1932. Then, we thought electrons, protons, and neutrons were the smallest, point-like particles. Again, we discovered that the story of protons and neutrons were not the smallest particles and settled on elementary particles. Elementary particles by definition are currently thought to not be composed of any smaller particles. But *déjà vu*, here we are again but this time could we be right?

> The list of elementary particles of the Standard Model—the particles that are supposed to be points—is a long one. It includes thirty-six distinct kinds of quarks, eight gluons, electrons, muons, tau leptons1 and their antiparticles, two kinds of W-bosons, a Z-boson, the Higgs particle, photons, and three neutrinos. Each type of particle is distinctly different from all the others. Each has its own particular properties. You might say they have their own personalities. But if particles are mere points, how can they have personalities? How can we account for all their properties, their quantum numbers, such as spin, isospin, strangeness, charm, baryon number, lepton number, and color? Particles evidently have a lot of internal machinery that can't be seen from a distance. Their pointlike, structureless appearance is surely a temporary consequence of the limited resolving power of our best microscopes, i.e., particle accelerators. Indeed the resolving power of an accelerator can be improved only by increasing the energy of the accelerated particles, and the only way to do that is to increase the size of the accelerator. If, as most physicists believe, the internal machinery of elementary particles were revealed only at the Planck scale, it would be necessary to build an accelerator at least as big as our entire galaxy! So we go on thinking of particles as points, despite the fact that they obviously have

so many properties. [1298]

Size of Atoms

How small are atoms? The picture below shows the size of a water drop and the scale of the particles that compose it.

Object -> Measurement (Inches)
Water Drop -> 0.04 inch
Water Molecule -> 0.00000001181102 inch
Hydrogen Atom -> 0.000000003937 00 inch
Quarks in Proton -> 0.00000000000003937007 inch
Quark -> 0.000000000000000003937007 inch
Preons? -> 0.0000000000000000000078740 16 inch [1299]

Preons are believed to exist, but their size makes it almost impossible to find directly. The size of a preon would be 1 X 10^{-21}. Here is something interesting about preons,

> Preons were originally proposed as quark constituents over three decades ago, but in 2005, Fredrik Sandin and Johan Hansson of the Luleå University of Technology in Sweden came up with the concept of preon "stars" or "nuggets" in space. These objects, made entirely of preons, but not in the form of quarks, would be somewhere between the size of a pea and a football, with a mass comparable to the Moon. Their density would be in the range between a neutron star–the densest ordinary form of matter–and a blackhole. The team believes preon nuggets could have been created in the early moments of the universe and lingered as a form of dark matter that primarily interacts with normal matter through gravity.[1300]

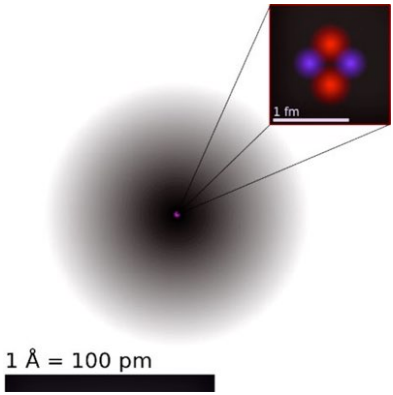
Just to give you an idea about the amount of energy stored in

atoms,

> Even if we were to convert just a single kilogram (1 kg) of mass into energy, the fact that c^2 [which is (299,792,458 m/s)^2] necessarily means that we'd get the equivalent of 21.5 megatons of TNT of energy out of that conversion. This explains why the Sun outputs so much energy; why nuclear reactors are so efficient; why the dream of controlled nuclear fusion is the "holy grail" of energy; and why nuclear bombs are both so powerful and so dangerous. [1301]

Composition and Dynamics

The image below is a depiction of a helium atom. The pink dot in the middle is the nucleus. The nucleus contains two protons in red and two neutrons in purple. The nucleus is held together by the strong force. [1302] The image shows a black area fading out into lighter and lighter shades of grey. This area depicts the electron cloud distribution for the helium atom. The nucleus for a neutral Helium atom has two protons and two neutrons. Protons have a charge of $+1$. Neutrons have charge of zero. Therefore, the nucleus of a Helium atom has a charge of $+2$. The Helium atom has two electrons in a single orbital cloud. Each electron has a charge of -1. Therefore, the total electron charge is -2. This means the total charge for the neutral Helium atom is 0 by simply adding the charge of the nucleus and the electrons.



1303

A human hair is about a million carbon atoms wide. More than 99.94% of an atom's mass is in the nucleus. The atom's electrons and nucleus are attracted to each other by electromagnetic force. The closer an electron is to the nucleus the stronger its electromagnetic attraction is. Molecules are formed by atoms whose electrons cease to form circular electron clouds around a single nucleus but deform the electron's orbital shape to incorporate more complex shapes formed by multiple nuclei. Protons have a positive charge and a mass 1,836 times that of the electron, at $1.6726 \times 10 - 27$ kg. Neutrons have no electrical charge and have a free mass of 1,839 times the mass of the electron, or $1.6749 \times 10 - 27$ kg. Protons and neutrons are welded together by one of the strongest forces in existence, the strong nuclear force. Left alone without large fluctuations of other energy, the protons attract the same number of electrons to make them neutrally charged or stable. The electron's cloud-like, uncertain orbits can reflect something like a planetary system orbiting a sun. However, electrons are not nearly as stable as planets. Orbital electrons obey the uncertainty principle. Electrons have no stable basis in 'reality'. They are wave-like and particle-like in a highly contingent fashion popping in and out of their hazy state utilizing zero-point energy.

Because electrons are fermions, they do not like to play with

each other. They are antisocial. The bosons are the Labrador Retrievers of the particle world. They love everyone and want to play with them all. However, we need introverted fermions for there to be anything we call existence. There is something called the Pauli exclusion rule which simply tells us that only one electron in an orbit is fine, but no more than two electrons can be in one orbital and even then, they can only share the orbit if one has spin-up and the other has spin-down. This will be discussed soon but the bottom line is, this ensures that electrons cannot just go willy-nilly into orbits and throw off the stability of the charge of an atom in normal circumstances. There would be no stable atoms without fermions and the Pauli exclusion rule.

Electrons are emergent, transforming themselves in response to wide ranges of energy fluctuations. They most easily absorb and reflect energy by changing their orbital levels. The orbital clouds farther out have less electromagnetic attraction and absorb and release energy more easily than the closer orbital clouds. If atoms did not reflect and absorb energy there would not be such things as stable atoms, which are the building blocks of the universe. Their transformative and emergent versatility enables them to stay structurally the same but different. The atom sets an orbit in which electrons are not allowed to go any lower called the base or fundamental orbit. Depending on their exposure to energy all the other higher orbits will remain stable. When an atom is in the presence of a more energetic field, the electrons absorb the energy which maintains the structure of the atom by jumping to higher energy levels. They do this by, in effect, popping out of existence by absorbing a photon and then popping back into existence at a higher orbital. On the other hand, when atoms are in the presence of a lower energetic field, they will pop out of existence giving off a photon and pop back into existence at a lower orbital level. Because they pop in and out of existence their orbitals are discrete. They never occupy the in-betweens of the orbitals. They have this kind of behavior because they are quanta, discrete wavicles.[1304]

In actuality and mathematically, an atom is a musical note. The fundamental, lowest orbit is the fundamental frequency. The higher orbits are the harmonics of the fundamental frequencies. Atoms sing when exposed to varying energy levels. Multiple atoms responding to varying energy levels are a symphony which we never 'hear' but live on a daily basis. Everything changes which means everything has a frequency. There are repetitive, enharmonic frequencies and non-repetitive, dissonant frequencies. Thus, we have relativity and quantum mechanics. But seriously, there is an amazing mathematics called Fourier analysis which breaks sound and any other repetitive phenomenon down into fundamental frequencies called the frequency domain. Complex frequencies, more than a simple sine wave, can be broken down into individual frequencies which, if added together, can come close to or very close to approximating the original complex frequency depending on how far out you take the transformation. The quantum Fourier transform can be used as a linear transformation of quantum bits (qubits). It can even be used for analyzing quantum probable states and probable transitions as the collapse or partial collapse of the quantum wave function in simpler ways than other techniques. Music is built on and in *phusis*. We just need to develop our ears to hear better.[1305]

In the world of relativity nothing can pop in and out of existence. Everything is smooth and continuous. Not so in the quantum world. In the quantum world everything is chunky and discontinuous. Chunky and discontinuous is the state of superposition. At the lowest levels of physics, stability is maintained in highly erratic, chaotic, unpredictable breaks from existence, space and time, cause and effect. There is no absolute which governs existence by strict determinism, rationality, or 'laws of physics'. All of this ontology, insistence on existence, at the most extreme levels is all too human, fantasies we tell ourselves that have nothing to do with what we have convinced ourselves is 'real'.

There are extreme processes which can transform and even destroy atoms. If we knock a proton and neutron out of the nucleus

or ‘fuse’ another proton and neutron into the nucleus we have done what the alchemists intuited, we have changed one base element into another base element. Fusion occurs when two light nuclei, not many protons and neutrons, combine together releasing vast amounts of energy contained by the strong force. Fission is when we split a heavy unstable nucleus into two lighter nuclei.[1306] Ionization occurs when we take a neutrally charged atom and add or remove electrons.

> The amount of energy needed to remove or add an electron —the electron binding energy—is far less than the binding energy of nucleons. For example, it requires only 13.6 eV to strip a ground-state electron from a hydrogen atom,[60] compared to 2.23 million eV for splitting a deuterium nucleus…
>
> By definition, any two atoms with an identical number of protons in their nuclei belong to the same chemical element. Atoms with equal numbers of protons but a different number of neutrons are different isotopes of the same element. For example, all hydrogen atoms admit exactly one proton, but isotopes exist with no neutrons (hydrogen-1, by far the most common form, also called protium), one neutron (deuterium), two neutrons (tritium) and more than two neutrons. The known elements form a set of atomic numbers, from the single-proton element hydrogen up to the 118-proton element oganesson. All known isotopes of elements with atomic numbers greater than 82 are radioactive, although the radioactivity of element 83 (bismuth) is so slight as to be practically negligible.[1307]

If an atom gains or loses an electron it becomes charged. This is one of the main causes of radiation. Radioactive decay occurs when nuclei become unstable and emit particles or electromagnetic radiation. There are three main types of radioactive decay:

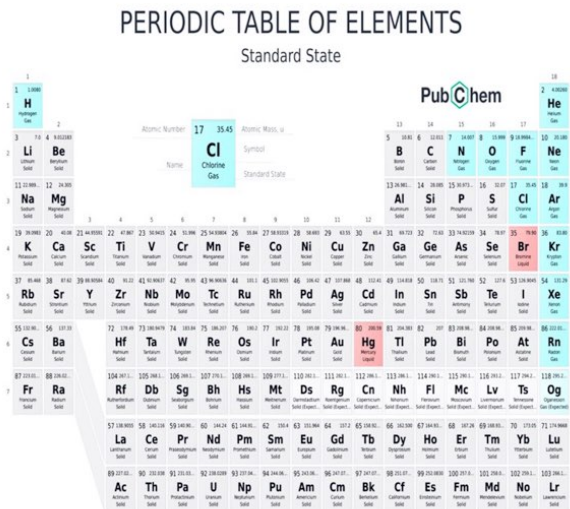
- Alpha decay is caused when a nucleus emits an alpha particle[1308] or two protons and two neutrons. The result is an atom or element with a lower atomic number or number of protons.
- Beta decay occurs when a neutron is converted to a proton which emits an electron and an antineutrino. Beta decay can also occur when a proton is converted into a neutron which emits a positron, the antiparticle of an electron, to a neutrino (an elementary particle shown below). This is governed by the weak nuclear force.[1309] A beta particle is a high-energy, high-speed electron or positron.[1310]
- Gamma decay results from a change in the energy level of a nucleus to a lower state usually preceded by the emission of an alpha or beta particle. [1311]

Atoms make up the Periodic Table of Elements shown below. This table displays all known atoms. This chart is used extensively in chemistry. The atomic number is the number of protons in the atom. For a neutrally charged atom the atomic number also equals the total number of electrons.

> About 339 nuclides occur naturally on Earth, of which 251 (about 74%) have not been observed to decay, and are referred to as "stable isotopes". Only 90 nuclides are stable theoretically, while another 161 (bringing the total to 251) have not been observed to decay, even though in theory it is energetically possible. These are also formally classified as "stable". An additional 35 radioactive nuclides have half-lives longer than 100 million years, and are long-lived enough to have been present since the birth of the Solar System. This collection of 286 nuclides is known as primordial nuclides. Finally, an additional 53 short-lived nuclides are known to occur naturally, as daughter products of primordial nuclide

decay (such as radium from uranium), or as products of natural energetic processes on Earth, such as cosmic ray bombardment (for example, carbon-14).[1312]

Periodic Table of Elements



[1313]

As you can see in the Periodic table, the change in protons and their equivalent neutrons also increases the number of electrons to make them stable.

The Standard Model of Elementary Particles

Atoms are made up of elementary particles described by the Elementary Particle Table shown below. We have an historically inherited commonsense idea that makes us think of some basic constituent of matter as a point, point-like. History has proven that the idea of a point-like particle is already an oversimplification, an abstraction which does not exist. Elementary particles are detailed

in the “Standard Model of Elementary Particles”. There are two categories of elementary particles:[1314]

- matter particles called fermions
- force particles called bosons

Particles, currently thought to be elementary, include electrons, the fundamental fermions (quarks, leptons, antiquarks, and antileptons, which generally are matter particles and antimatter particles), as well as the fundamental bosons (gauge bosons and the Higgs boson), which generally are force particles that mediate interactions among fermions.[1315] For an elementary particle there are three basic properties: mass, charge, and spin.[1316]

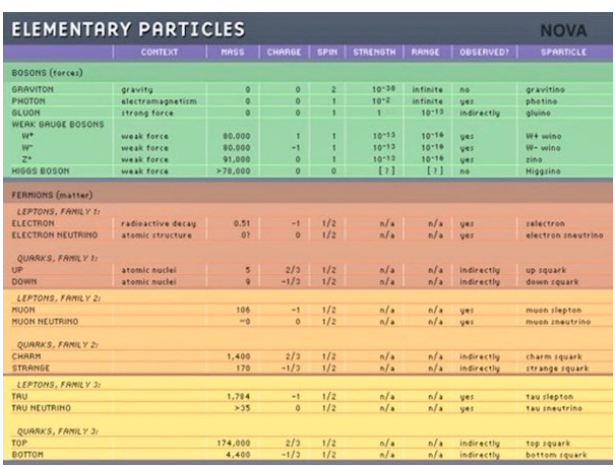
> Mass: A particle has mass if it takes energy to increase its speed, or to accelerate it…The values are given in MeV/c2s (that is pronounced megaelectronvolts over "c" squared), that is in units of energy over the speed of light squared. This comes from special relativity, which tells us that energy equals mass times the square of the speed of light. All particles with mass-produce gravity. All particles are affected by gravity, even particles with no mass like the photon (see general relativity).
>
> Electric charge: Particles may have positive charge, or negative, or none. If one particle has a negative charge, and another particle has a positive charge, the two particles are attracted to each other. If the two particles both have negative charge, or both have positive charge, the two particles are pushed apart. At short distances, this force is much stronger than the force of gravity which pulls all particles together. An electron has charge -1. A proton has charge +1. A neutron has an average charge 0. Normal quarks have charge of ⅔ or -⅓.
>
> Spin: The angular momentum or constant turning of a

particle has a particular value, called its spin number. Spin for elementary particles is one or ½. The spin property of particles only denotes the presence of angular momentum. In reality, the particles do not spin.[1317]

The charts below illustrate how these elementary particles break down along with their properties. Note that gravitons have not yet been proven to the most rigorous standards of physics, but it is included because physicists know a good bit about where gravitons will fit into the table of elementary particles. When gravitons are proven it will have to be indirectly proven due to its incredibly small strength. The graviton is expected to be massless[1318] which means it travels at the speed of light in a vacuum.[1319] Gravity waves which have been proven to exist also travel at the speed of light. Any particle which has no mass will travel at the speed of light. The Higgs boson was proven to exist by CERN in 2012.[1320]

As you can see, depending on the elementary particle mass, charge, and spin can be zero. According to current quantum field theory every charged particle has an antiparticle.[1321]

Elementary Particle Table



ELEMENTARY PARTICLES — NOVA

	CONTEXT	MASS	CHARGE	SPIN	STRENGTH	RANGE	OBSERVED?	SPARTICLE
BOSONS (forces)								
GRAVITON	gravity	0	0	2	10^{-38}	infinite	no	gravitino
PHOTON	electromagnetism	0	0	1	10^{-2}	infinite	yes	photino
GLUON	strong force	0	0	1	1	10^{-13}	indirectly	gluino
WEAK GAUGE BOSONS								
W+	weak force	80,000	1	1	10^{-13}	10^{-16}	yes	W+ wino
W−	weak force	80,000	−1	1	10^{-13}	10^{-16}	yes	W− wino
Z°	weak force	91,000	0	1	10^{-13}	10^{-16}	yes	zino
HIGGS BOSON	weak force	>78,000	0	0	[?]	[?]	no	Higgsino
FERMIONS (matter)								
LEPTONS, FAMILY 1:								
ELECTRON	radioactive decay	0.51	−1	1/2	n/a	n/a	yes	selectron
ELECTRON NEUTRINO	atomic structure	0?	0	1/2	n/a	n/a	yes	electron sneutrino
QUARKS, FAMILY 1:								
UP	atomic nuclei	5	2/3	1/2	n/a	n/a	indirectly	up squark
DOWN	atomic nuclei	9	−1/3	1/2	n/a	n/a	indirectly	down squark
LEPTONS, FAMILY 2:								
MUON		106	−1	1/2	n/a	n/a	yes	muon slepton
MUON NEUTRINO		<0	0	1/2	n/a	n/a	yes	muon sneutrino
QUARKS, FAMILY 2:								
CHARM		1,400	2/3	1/2	n/a	n/a	indirectly	charm squark
STRANGE		170	−1/3	1/2	n/a	n/a	indirectly	strange squark
LEPTONS, FAMILY 3:								
TAU		1,784	−1	1/2	n/a	n/a	yes	tau slepton
TAU NEUTRINO		>35	0	1/2	n/a	n/a	yes	tau sneutrino
QUARKS, FAMILY 3:								
TOP		174,000	2/3	1/2	n/a	n/a	indirectly	top squark
BOTTOM		4,400	−1/3	1/2	n/a	n/a	indirectly	bottom squark

The table above (click the link above for a larger image) is called the Standard Model of Elementary Particles. The sparticle column on the right shows what the supersymmetry, super partner would be if it existed. So far, none of the sparticles have been proven to exist.

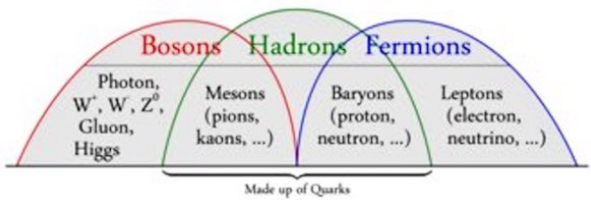
If you look at the spin quantities in the table above, they are either ½, 1, or 2. The equivalent of this as rotation would be 180 degrees, 360 degrees, or 720 degrees. However, those inner degrees to these quantized states would be called fractional spin. One important idea to understand about quantization is that none of these particles can be isolated and measured singly precisely due to complementarity which I previously discussed. The measured properties we assign come from many measurements averaged over time. In quantum field theory quantization of properties like spin and charge are necessary to involve mathematical infinites upon infinites which would require the entire universe. Therefore, for practicability and useability, a process called renormalization subtracts these infinites and provides us with usable quantized values which work for many uses in quantum physics, chemistry, biology, and especially in quantum computing.

Renormalization is a symptom of something much bigger in physics – the insufficiency of commonly used language to contain physical ideas. Frank Wilczek is an American theoretical physicist and mathematician and Nobel laureate. He is currently the Herman Freshbach Professor of Physics at MIT. Wilczek explains the problems of language,

> Language is a social creation. It encodes the common experience of many people, past and present, and has been sculpted mainly to communicate our everyday needs. Ordinary language is most certainly not a product of the critical investigation of concepts. Yet scientists learn, think

and communicate in it during much of their lives. Ordinary language is therefore an unavoidable scientific tool — rich and powerful, but also quite imperfect.[1323]

Let's go back to hadrons. Most people are familiar with the Large Hadron Collider (LHC) in Geneva, Switzerland. [1324] There is a reason why hadrons deserve the name of a supercollider. Hadrons are particles that are composites of other subatomic particles. There are two kinds of hadrons: Mesons and Baryons. Mesons are bosons with integer spin such as 0, +1, -1. Baryons are fermions with half-integer spin such as +3/2, -3/2, +1/2, -1/2.



[1325]

A hadron is made up of two or more quarks held together by the strong force or strong interaction. A baryon is made up of an odd number of quarks, usually three. Mesons are made up of an even number of quarks, usually two quarks: a quark and an antiquark. Quarks are never found outside of hadrons. Baryons make up the force which holds protons and neutrons together and make up the majority of mass of an atom. The funny thing about how this force works is that when protons and neutrons are about one proton width apart, they attract by exchanging pions which are mesons. However, if the distance gets closer to one proton width apart, they repel each other. Exotic hadrons and mesons have been discovered in recent years. [1326] When the LHC crashes them together a burst of hadrons decay into other particles.[1327] Quarks are the only particle in the Standard Model which have a part to play in all four

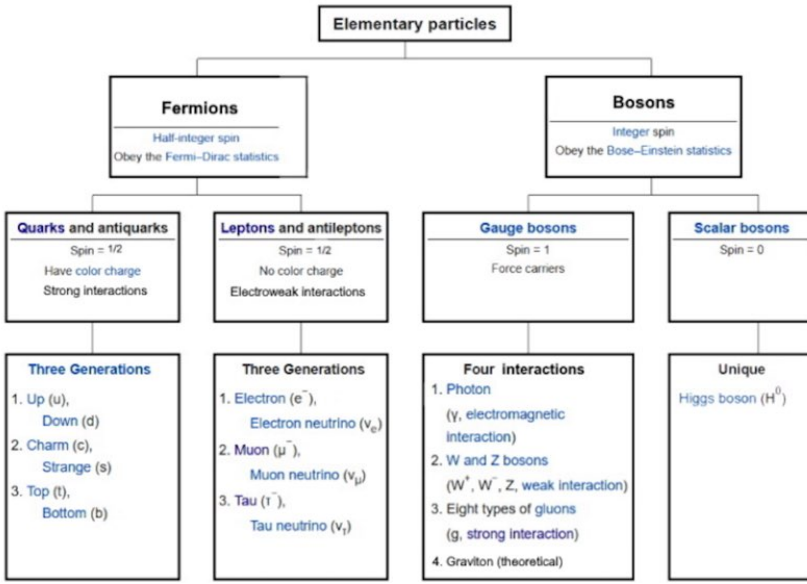
fundamental forces: electromagnetism, gravitation, strong interaction, and weak interaction. [1328] A gluon is an elementary particle which mediates the strong interaction, the strong force which holds nuclei together, between quarks.

> The full wavefunction of any hadron must include virtual quark pairs as well as virtual gluons. Also, there may be hadrons which lie outside the quark model. Among these are the glueballs (which contain only valence gluons), hybrids (which contain valence quarks as well as gluons) and multiquark states (such as the tetraquark mesons which contain two quark-antiquark pairs as valence particles, or the pentaquark baryon which contains four quarks and an antiquark in the valence). [1329]

Our current thinking of point-like particles are quarks, leptons, and bosons.

> At our current level of understanding, the elementary particles are quarks, leptons (such as the electron) and bosons (such as the photon). These particles are all imagined as pointlike, so you might wonder how they can have spins. A simple answer might be, perhaps they are composite, too. But deep theoretical reasons having to do with the rotational symmetry of nature lead to the existence of spins for elementary objects and to their quantization.[1330]

Elementary Particle Chart



1331

However, at this level even these particles get really complicated.

> Quarks and gluons are the building blocks of protons and neutrons, which in turn are the building blocks of atomic nuclei. Scientists' current understanding is that quarks and gluons are indivisible—they cannot be broken down into smaller components. They are the only fundamental particles to have something called color-charge. Quarks can have a positive or negative electric charge (like protons and neutrons). Gluons have no electric charge. Both quarks and gluons have three additional states of charge: positive and negative redness, greenness, and blueness. These so-called color charges are just names—they are not related to actual colors. The force that connects positive and negative color charges is called the strong nuclear force. This strong nuclear force is the most powerful force involved with holding matter together. It is much stronger than the three other

> fundamental forces: gravity, electromagnetism, and the weak nuclear forces. Because the strong nuclear force is so powerful, it makes it extremely difficult to separate quarks and gluons. Because of this, quarks and gluons are bound inside composite particles. The only way to separate these particles is to create a state of matter known as quark-gluon plasma. In this plasma, the density and temperature are so high that protons and neutrons melt. This soup of quarks and gluons permeated the entire universe until a few fractions of a second after the Big Bang, when the universe cooled enough that quarks and gluons froze into protons and neutrons. Today, scientists study this quark-gluon plasma at special facilities such as the Relativistic Heavy Ion Collider (RHIC) at Brookhaven National Laboratory.[1332]

At the level of quarks, leptons, and bosons we are getting into the mathematics of string theory or branes (pick your poison). This mathematics uses higher dimensional mathematics in addition to the four dimensions of spacetime Einstein wrote about. These higher dimensions can start at around six more for a total of ten dimensions and go up from there.

> The five different string theories had a few commonalities. For one, they all involved strings. They also all required our universe to have 10 total dimensions: the usual three spatial dimensions, one for time and six more compact dimensions that are tiny and curled up on themselves at submicroscopic scales.[1333]

These additional dimensions are compacted or rolled up into Planck levels, so we see the strings as point-like.

> Sometimes strings can wind around a tiny, curled-up dimension a certain number of times with a certain

> momentum, but the duality of that has the number of windings and the momentum flipped.[1334]

Why do we need to resort to these higher geometric dimensions to explain point-like particles? By using higher dimensional math developed in string theory we can more eloquently and accurately model and predict their behavior. In other words, point-like particles seem to act like multidimensional particles greater than the four dimensions (3 space + 1 time) of general relativity. A point is one dimensional. In order to explain the strange behaviors of one-dimensional objects, more dimensions are needed.

> And in all the theories, the ways strings vibrate give rise to the richness of our physical world, from the forces of nature to the building blocks of matter to physical constants themselves. But when it comes to physical theories, details matter, and the five competing string models differed in the details. Some theories only had closed loops of strings, while others allowed open, wiggling strings. Some theories only allowed vibrations to travel in one direction on the strings, while others allowed both. And some theories were combinations of other theories.[1335]

In 1984, Edward Witten, a physicist and mathematician, wrote a paper describing radioactive decay in ten dimensions. The mathematics of his paper proved useful to study radioactive decay. This is how string theory found acceptance in the physics community.[1336] However, there were five different string theories that explained quantum phenomenon. Witten noticed that the five string theories all had similarities like, for example, dualities or symmetries. Dualities occurred around a curled-up dimension which wound up a certain number of times and had momentum. Another string theory had the same number of curled up windings, but the momentum was reversed. Then in 1995 Witten gave a talk giving a

novel suggestion that all five string theories were not so different. Witten noticed links and symmetries which he said pointed to something new. That is when Witten's suggestion that the 'something' new be called M-Theory.

M-Theory where the 'M' may have meant 'mother, 'mystery' or 'membrane' later shortened to branes. Not only did branes unify all five strings but it also showed that all five strings were just low power versions of eleven dimensions. These branes are like a membrane on which our universe grows.[1337] In the 1990s there was much interest in branes in cosmology as multiple universes which each had their own branes. However, so far that has not been proven to the strict satisfaction of most physicists and there is pessimism that it ever will be. In any case, the mathematics of strings and branes is still very much accepted by many physicists.

What is Spin?

Let's start this discussion with a widely used notion of particles called spin. Why is spin important? What is spin? It is not what you might think. It is not rotation.

> Yet spin is deeply important. If electrons didn't seem to spin, your chair would collapse down to a minuscule fraction of its size. You'd collapse, too—and that would be the least of your problems. Without spin, the entire periodic table of elements would come crashing down, and all of chemistry would go with it. In fact, there wouldn't be any molecules at all. So spin isn't just one of the best tricks that electrons pull; it's also one of their most crucial.[1338]

All of the properties of elementary particles except the Higgs boson have spin. However, 'spin' is an oversimplification. They do not spin like our water-top example earlier. Let's remember that particles are both particles and waves which physics calls wavicles.

What would it mean for a wave to spin?

> …the very notion that electrons and protons are solid 'objects' that can 'rotate' in space is itself difficult to sustain [1339]

We already discussed spin as a mechanical kind of “water-top” but actually spin is not mechanical at all. More correctly, the ‘spin’ of a charged subatomic particle is really quantized angular momentum. For charged particles think of a very tiny magnetic field that they produce in which the fields themselves are measured to have angular momentum.[1340] However, this is not like a magnetic field spinning or going around 360 degrees. The ‘spin’ in elementary particles is quantized which means the angular momentum only has discrete states of spin.

> Spin is a bizarre physical quantity. It is analogous to the spin of a planet in that it gives a particle angular momentum and a tiny magnetic field called a magnetic moment. Based on the known sizes of subatomic particles, however, the surfaces of charged particles would have to be moving faster than the speed of light in order to produce the measured magnetic moments. Furthermore, spin is quantized, meaning that only certain discrete spins are allowed. This situation creates all sorts of complications that make spin one of the more challenging aspects of quantum mechanics.[1341]

As an example, let’s use electrons. One of the properties of electrons has traditionally been called spin. However, this is an oversimplification which makes us think that electrons spin. Let’s remember that electrons are wavicles. An electron is a particle and wave. What would it mean for a wave to spin?

> …the very notion that electrons and protons are solid

'objects' that can 'rotate' in space is itself difficult to sustain
1342

I have already covered the idea of spin with the analogy of water-tops. Some elementary particles have a tiny electric charge like electrons. Other elementary particles have no charge like a photon. But almost all elementary particles shown in the ‘Elementary Particle” table detailed in the section entitled “The Standard Model of Elementary Particles” have spin. The Higgs Boson is the only exception with no spin.

More correctly, the ‘spin’ of a charged subatomic particle is really quantized angular momentum of a very tiny magnetic field that they produce. We do not actually see a ‘particle spin’. A charged particle has an electric field. As I discussed earlier, an electric field will generate a magnetic field ninety degrees out of phase with the electric field’s flux lines. In an electron, we see effects of a magnetic field which rotates evidenced by angular momentum. While the idea of spin has some visual usefulness, it also has some misleading downsides due to oversimplification. With this in mind, spin plays very heavily in chemistry. It determines how electrons are arranged around the nucleus of atoms in quantum energy levels. There would be no chemistry or ‘Periodic Table of Elements’ if it were not for electron spin. In any case, the idea of spin as a point-like particle tells us something about ourselves and about a recurrent theme in physics.

For physicists when they talk about spin, they are referring to a special kind of angular momentum. The most common way to think of angular momentum is the tendency for a rotational body to stay in rotational motion. Inertia is the tendency for a body to oppose a change in its motion. The moment of inertia, otherwise called angular inertia, is the tendency for a rotating body to resist a change to its rotating motion. Swatting a fly is easy but try swatting a bowling ball coming at you. This is because the mass of the bowling ball is larger than the mass of a fly. And guess what, even

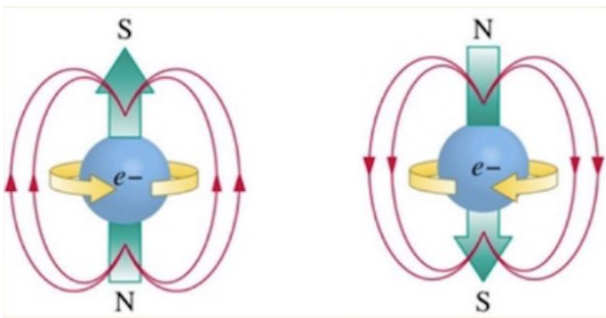
if you put both in the weightlessness of space you would still prefer a fly coming at you rather than a bowling ball (unless the fly was accelerated close to the speed of light and assuming the fly did not fly apart). At sub-light speeds, the mass of the bowling ball is more than the mass of a fly whether you are on the earth or in space. Mass also affects rotation in the same way when it comes to angular momentum, the tendency for a rotating object to keep rotating, and angular inertia, the tendency for a body to resist a change to its rotation. Gravity, spacetime curvature, has nothing directly to do with inertia at sub-light speeds. Inertia has to do with mass. What is called the moment of inertia is another way of saying angular inertia. This means the tendency for a body that is rotating to keep rotating.

With that in mind, when we talk about particle spin, we are not talking about rotation, but we are still talking about angular momentum. The problem understanding quantum particle spin is thinking of the particle as a point particle. If an electron were *rotating* with the same angular momentum, we know that electrons have, it would have to spin faster than the speed of light. This is not happening. An electron is not actually spinning but it has a tendency to spin in a certain direction. The best way to think of particle spin is as a field. We know that a quantum particle's complementarity is as a particle and as a wave.

An electron wave is not a water wave as in the water-tops analogy, so it is better to think of an electron wave as a field, like a magnetic field. Fields can move straight ahead as in translation, or they can rotate in a circular fashion. Plus, fields are spread out much wider than a point particle so an electron as a rotating field would not have to rotate nearly as fast as a point particle would have to, to have the same angular momentum. Think of an ice dancer rotating; when she pulls her hands in towards her body, she spins faster. This is because her angular momentum wants to stay the same and pulling her hands in causes her to rotate much faster.[1343] However, an electron as a spread-out field, not a point-

particle, is more like a tiny electrical/magnetic field.

The best way to think of spin for an electron is like a tiny magnet with a north and south pole, a dipole (two poles). The flux lines for a magnet are circular or oblong. The diagram below shows a tiny electric field (yellow) which has a charge (e-) and the magnetic field (red) which emerges from the electric field. The first diagram depicts spin up and the second diagram depicts spin down. Note that the magnetic field is really a three-dimensional, torus type object. This is like the magnetic field flux field lines around the earth from the north to south poles.



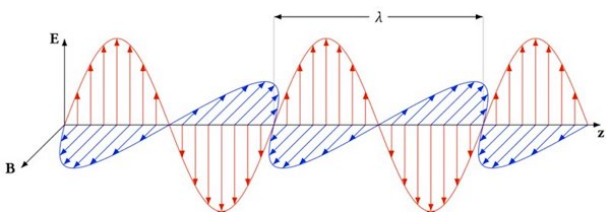
1344

From the diagram above you can see that the flux lines pull in a rotational direction. If you put a tiny electron magnet in a large magnetic field the tiny magnet will be attracted to the opposite pole direction of the large magnetic field with a certain force due to the strength of the tiny magnetic field. In that case, the electron has a preferred direction or vector set by the larger magnetic field.1345 Because the electron has mass it will have angular momentum and angular inertia. The tiny flux lines of an electron have angular momentum and inertia. Angular momentum is the force or tendency to prefer an angular orientation in a field. Angular inertia, the moment of inertia, is the force or tendency for an electron to stay oriented angularly in a field. So, if you could push a force in a

direction not consistent with its angular orientation, you would have to overcome those forces with a stronger force or acceleration.

Here is another important point about particle/field spin. Particle/field spin is discrete. Electrons have tiny angular momentum fields in two directions like the magnet poles of north and south. These two directions are called dipoles. Because electron spin has a tiny dipole the Pauli exclusion principle works. Electrons are fermions which means they actually have half spins or fractional spins. The negative charge of electrons causes them to orbit around the positively charged nucleus of an atom in discrete energy clouds.

Photons are bosons. They are extroverts like Laboratory Retrievers and like to play with everyone. Therefore, the Pauli exclusion rule does not apply to them. Photons are massless and have no charge. Yet they still have spin.[1346] A photon's spin can be thought of more as a dipole of polarization. A photon can have left or right polarization or a superposition of the two. This also applies to electrons which can have spin-up or spin-down of a superposition of the two. The spin angular momentum of a photon is equal to h+ or h- where h is the reduced Planck constant.[1347] The polarization of the photon is ninety degrees out of phase corresponding to the electric and magnetic fields.



[1348]

A "vertically polarized" electromagnetic wave of wavelength λ has its electric field vector E (red) oscillating in the vertical direction. The magnetic field B (or H) is always at right

angles to it (blue), and both are perpendicular to the direction of propagation (z).[1349]

Lambda (λ) in the diagram is the wavelength of light in a vacuum. The frequency (f) is equal to c (the speed of light divided by λ, the wavelength). As shown in the previous section entitled "Fields," in the "Electromagnetic Spectrum Table" frequencies range from 3 hertz to 300 exahertz or 300 X 10^{18} hertz.

Relativity on the Quantum Scale

Fundamentally built into relativity is four dimensional spacetime and the idea that the speed of light is an absolute limit in the universe. Intuitively, we think of space as three dimensions and time as one dimension. However, relativity tells us that, mathematically and practically, in relativity space and time are four dimensions. Space does not move through one dimension of time. So, how does spacetime relate to mass and energy? First, Let's clarify a few ideas with regard to Einstein's famous formula $e = mc^2$.

According to $e = mc^2$, mass is energy and energy is mass, but this requires more explanation. Rest mass (called invariant mass) is mass which has no momentum. Rest mass is the total mass/energy that is the same in all relative frames of reference. Rest mass is Newtonian mass. Rest mass is the sum total quantity of mass/energy in a body or system divided by c^2. So, the famous formula is really: $e_{rest} = m_{rest}c^2$. Rest mass does not require bound particles or what we think of as an object. This means rest mass can also apply to unbound particles. As such, rest mass, or more customary for particle physics, rest energy, is often employed in particle physics for systems which consist of widely separated high-energy particles.

The conservation of energy tells us that momentum or rest mass/energy is conserved in an ideal isolated system. An ideal isolated system does not happen in the real world as momentum or

rest mass/energy can be transformed into other forms of energy such as heat which moves toward more disorder or entropy. Also, massless particles such as photons have zero rest mass, but massless particles have both momentum and energy from our relative frame and travel at the speed of light in a vacuum. If I am moving with the center of momentum of a mass, I will only see the mass' rest mass. If I am not moving with the center of momentum of a mass (i.e., in another relativistic frame), as the speed gets closer to the speed of light, I will see the relativistic mass.

Relativistic mass is more complicated than $e_{rest} = m_{rest}c^2$. First, inertia is the resistance offered by a body to its motion whereas momentum is the tendency of a body to continue moving. Inertia is the resistance of a body to change its motion. One way to think of it is that it is harder to accelerate a larger object than a smaller object. On the flip side, it is harder to slow down a larger accelerating object than a smaller accelerating object. This is called momentum.

If I am observing a mass accelerating away from me in spacetime, as it gets closer to the speed of light, I will see more energy being applied to the mass. Therefore, I will see that the mass will have more kinetic energy. Rest mass will stay the same as it does not care about relative frames. But from my relativistic frame I will see that the mass acquires more momentum as it is being accelerated. Also, inertial mass, the resistance of mass to changing its motion will increase. What I am seeing is the conversion of mass into more and more energy. We have heard folks say mass increases to infinity as we approach the speed of light but what we are really seeing is that inertial mass (the resistance to change of motion) is increasing to infinity. Let's call this mass/energy.

Relativistic mass/energy is the total amount of energy in an object. The relativistic mass/energy of an object includes a contribution from the "net" kinetic energy from the center of mass/ energy of the object which gets larger and larger the faster the body moves. The relativistic mass/energy depends on the observer's

relativistic frame. The measurable inertia and the warping of spacetime by an object in a given relativistic frame is determined by its relativistic mass/energy, not merely its invariant or rest mass. For example, photons have zero rest mass but contribute to the inertia (and weight in a gravitational field) of any relativistic frame containing them. Relativistic mass/energy in larger mass/energy systems is an important factor. By “larger mass/energy systems” I mean bound systems like atoms and above. Relativistic mass/energy is not really a consideration when it comes to unbound particle physics. So already we see that from the perspective of unbound particle physics space/time is non-existent. Rest spacetime is Newton’s absolute time and space. It is interesting to note that even spacetime has ‘rest spacetime’ and ‘relativistic spacetime’, Newton’s space and time or Einstein’s spacetime. Relativistic spacetime accounts for time dilation and length contraction where from our relativistic frame something in another relativistic frame is approaching the speed of light. This will be discussed later. Relativistic mass/energy curves spacetime, even for atoms. However, much smaller unbound particles don’t even know spacetime exists.[1350]

Since mass/energy curves spacetime it sets up meandering paths like paths climbing up a mountain trail. A topographic map shows elevation changes with contour lines. Now, apply the topographic map to the idea of spacetime contour. We can now call these contour lines geodesic lines. If you lived on a plane, the shortest line between two points would be a straight line. However, if you lived on the surface of a sphere the shortest line between two points would be an arc which follows the surface of the sphere. If you live in spacetime the shortest distance and time between two places in spacetime is the geodesic line. Now, remember inertia - the ability of an object to resist a change in its motion? Geodesic lines in spacetime follow the lowest point of inertia for any object traveling along it. If you drop an object on earth, it will fall straight down disregarding wind. Analogously, if you were to ‘drop an object’ in

spacetime it would tend to fall along the geodesic line. On earth we call this ‘gravity’ but that is really a kind of misnomer. What we are really seeing is that an object wants to follow the path of least resistance - it opposes changes in its motion. However, this is not just distance, it is time as well.

Practically, what this means is that the only way to preserve the relativity of spacetime created by the speed of light is to lose the notion of simultaneity of events and the fixed dimensions of size. We also need to give up the idea that mass and energy are two different ‘things’. We need to lose the idea that spacetime is passive with regard to everything in it. We also need to lose the idea that space, as linear extension, and time, as a succession of linear ‘now’ moments, exists. The idea that we are subjects living in our abstract narratives of space and time are given by classical history not by *phusis* itself. Our ideas about reality are not reality at all. Even more, these ideas of ‘reality’ given by history, language, and custom are narratives not *phusis* itself. We are all lacking when it comes to finding a new narrative that will fill the gap of any such thing as ‘reality’ could be. Additionally, we need to lose the idea that something cannot be a wave and a particle at the same time. This is just one example of Niels Bohr’s complementarity principle.

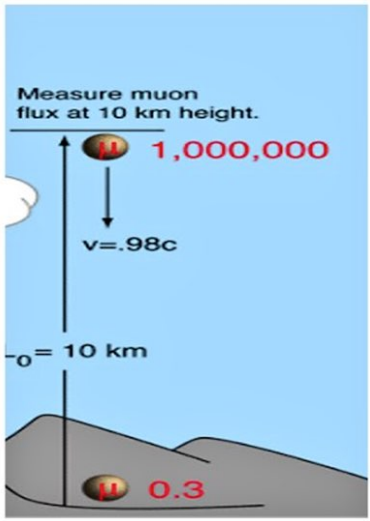
The complementarity principle is not just with wave/particle duality called wavicle. We see it in the very small of quantum physics and the very large of general relativity. It comes up in many forms in 20th century physics which I will get into more. For now, one example would be the contradictory way in how reality looks from outside a blackhole and from inside a blackhole. I will get into that more later as well. The point is that the complementarity principle is a nice name for accepting our historic notion of contradiction as fundamental, as essence. To withdraw from this is to retreat to history, to try to find dwindling meaning in yet one more replication of the simulacra of history. Below the level of contradiction is the fear of chaos. This is Orpheus’ death stare as the abyss looks back at us. Chaos is only fearful when we are

exasperated and fixated on forcing it to not be so. However, there is another way to stare at the abyss - as an extreme excess which we cannot account for or take hold of, not even in negation. Negation caps off the abyss as a known, as a negation. The negation bleeds with an excess which it cannot contain. More on all this later. Let's continue with the odd notion of spacetime.

Space Time Relativity

Space is time and time is space. They are the same 'thing'. If you change your position in space, you will also change your position in time. When astronauts stay in space for extended periods of time, they are younger when they return. If you spend more time at the top of a skyscraper, you will be younger when you come down to the ground. When one stationary clock remains in one place and another clock which is synchronized to the stationary clock is flown westward around the world, the moving plane's clock will be 273 nanoseconds faster.[1351] Here is another example,

> Muons are cosmic ray particles formed in Earth's atmosphere. When formed, they travel at velocities near the speed of light towards Earth's surface. However, due to their extremely short half-life, majority of muons would decay before reaching the surface. [1352]



In an experiment conducted at Mount Washington, quantities of muons were measured at the summit and bottom of the mountain. These numbers were then compared. A greater proportion of muons was detected at sea level compared to what was originally predicted by considering the muons' average velocity and half-life at rest (1.5 μs).

Evidence for Time Dilation

This observation can be accounted for using time dilation. When muons are moving near the speed of light (0.98c), their half-life is increased when measured by a stationary observer on Earth. This dilated half-life as observed by an Earth-bound observer allows muons to reach the surface of Earth before decaying.

Evidence for Length Contraction

This observation can also be accounted for using length contraction. In the muons' frame of reference, the distance between the top of Mount Washington and sea level becomes shorter due to length contraction.

Therefore, in the same amount of lifetime before decaying, more muons can reach Earth's surface.[1354]

The Wormhole

As I mentioned, Einstein published two very important papers in 1935. One paper dealt with what we now know as blackholes and how they could be connected by what we call a wormhole or what physicists call an Einstein-Rosen bridge. This journal article was authored by Einstein and Rosen, which we will henceforth call the ER paper.[1355] It is interesting to note that in 1939 Einstein published in the Annuals of Mathematics another paper entitled "On a Stationary System with Spherical Symmetry Consisting of Many Gravitational Masses" where he argued that the existence of blackholes was impossible. A Few months later Robert Oppenheimer (1904-1967) published a paper entitled "On Continued Gravitational Attraction" in which he argued that Einstein's own general theory of relativity already proves that blackholes could exist. Oppenheimer's view became the accepted position of physicists. Later Einstein's invention of quantum-statistical mechanics proved that eventually every astronomical object would collapse into a blackhole resulting in a universe that would have no resemblance to the one we live in.

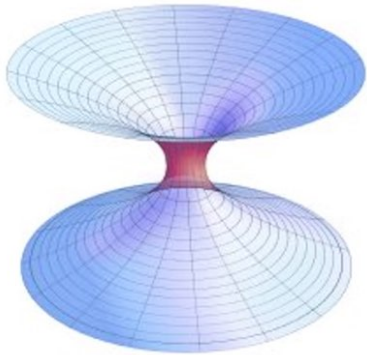
> Great science sometimes produces a legacy that outstrips not only the imagination of its practitioners but also their intentions. A case in point is the early development of the theory of blackholes and, above all, the role played in it by Albert Einstein. In 1939 Einstein published a paper in the journal Annals of Mathematics with the daunting title On a Stationary System with Spherical Symmetry Consisting of Many Gravitating Masses. With it, Einstein sought to prove that blackholes--celestial objects so dense that their gravity prevents even light from escaping--were impossible.

> The irony is that, to make his case, he used his own general theory of relativity and gravitation, published in 1916--the very theory that is now used to argue that blackholes are not only possible but, for many astronomical objects, inevitable. Indeed, a few months after Einstein's rejection of blackholes appeared--and with no reference to it--J. Robert Oppenheimer and his student Hartland S. Snyder published a paper entitled On Continued Gravitational Contraction. That work used Einstein's general theory of relativity to show, for the first time in the context of modern physics, how blackholes could form.
>
> Perhaps even more ironically, the modern study of blackholes, and more generally that of collapsing stars, builds on a completely different aspect of Einstein's legacy--namely, his invention of quantum-statistical mechanics. Without the effects predicted by quantum statistics, every astronomical object would eventually collapse into a blackhole, yielding a universe that would bear no resemblance to the one we actually live in.[1356]

One other point here is the new Oppenheimer movie is promoting the idea that Oppenheimer first coined the term 'blackhole' but the American Museum of Natural History states that

> "*The term "blackhole" was itself coined in 1968 by the Princeton physicist John Wheeler, who worked out further details of a blackhole's properties.*[1357]

The ER paper dealt with the very large and massive parallel sheets of spacetime curved by gravity. We can understand this as what is produced by the geometries of two blackholes.



1358

No person could ever travel all the way through the wormhole due to the infinitesimal singularity. Here are some ideas about what would happen,

> For decades, the general consensus among theoretical physicists was that if you fell feet-first into a blackhole, the gravitational pull on your feet would be so much stronger than on your head that it would stretch you out like one long, thin noodle.
>
> But recently, some physicists have proposed a new theory that suggests a person falling into a blackhole would, at some point, meet a wall of fire and get burned up on the spot. This is the "firewall" argument.1359

In effect, a wormhole would be a bottomless pit. Any 'thing' that fell into it could never reach the other side. However, it might be that information could be transmitted through the wormhole. This abstract of Susskind and Zhao's paper entitled, "Teleportation Through a Wormhole" tells us,

> ER = EPR allows us to think of quantum teleportation as communication of quantum information through space-time

> wormholes connecting entangled systems. The conditions for teleportation render the wormhole traversable so that a quantum system entering one end of the ERB will, after a suitable time, appear at the other end. Teleportation requires the transfer of classical information outside the horizon, but the classical bit-string carries no information about the teleported system; the teleported system passes through the ERB leaving no trace outside the horizon. In general the teleported system will retain a memory of what it encountered in the wormhole. This phenomenon could be observable in a laboratory equipped with quantum computers.[1360]

Moreso, it may be that quantum entangled qubits or any entangled particles have extremely small wormhole singularities connecting them. Maybe a wormhole links all entangled particles in the universe, forging a spatial connection that records their shared histories. Maybe Einstein's hunch that wormholes have to do with particles was right.[1361] From Einstein on, physicists have mathematically shown that wormholes are possible. Susskind and other physicists have also demonstrated ways in which blackholes are entangled and produce entangled wormholes. MIT physicists have found that entanglement gives rise to wormholes.[1362] Is it possible that blackholes could be highly entangled systems? If so, exformation would be exchanged between blackholes but without regard to spacetime or any 'thing' in it.[1363]

In any case, both blackholes could meet in the infinitesimal middle of the wormhole. What would this be? Some have speculated it would be a frothy entangled quantum foam which would pop in and out of existence as matter and antimatter that would instantly create and destroy each other.[1364] In our universe, this dynamic is called virtual particles because it does not 'exist' in any detectable way – it has no reality other than a purely mathematical representation we call the wave function. Blackholes

are phenomenal examples of where the very large (e.g., gravity) and the very small (e.g., quantum mechanics) meet. In this way, they have been a real clue as to how to combine these disparate extremes. Quantum gravity has been around a long time, well researched, and a promising solution to this problem.

Quantum Foam, Cosmological Constant, and the Cosmic Microwave Background

Quantum foam is a theoretical quantum fluctuation of spacetime on very small scales due to quantum mechanics. Quantum foam is zero-point energy, the vacuum energy of virtual particles popping in and out of existence as the fabric of spacetime itself, of the universe. Quantum foam at these smallest scales bubbles and gurgles as particles of matter and antimatter are created and destroyed. The very geometry of spacetime fluctuates like foam. Quantum foam is not nothing and it is not something. It has a hazy middle. Quantum foam is essentially related to the cosmological constant. The cosmological constant addresses flat, positive, and negative curvature – the geometry of spacetime. A vacuum pervaded by spacetime foam might possess an enormous intrinsic energy. Such an energy would act like the cosmological constant, a fixed parameter that was added to the equations of general relativity. In other words, the energy of the vacuum could be responsible for the observed acceleration of the universe's expansion, which is currently attributed to dark energy. The cosmological constant guarantees that there will be a dynamic fine balance, a fine dance, between repelling and attracting forces in the universe. This way the universe will not expand or collapse too fast. [1365]

Let's imagine we threw a ball into the air. At some point the kinetic energy of the throw would go to zero and the potential energy due to the earth's gravity, spacetime curvature, would cause the ball to fall back to the earth. Now imagine that we throw the

ball so hard that it escapes the pull of the gravity of earth. It would leave the earth and never return. There is also an amount of kinetic energy of the throw which would not allow the ball to come back but neither would it allow the ball to completely escape the earth's gravity. That would be called orbit.

Another way to think about this is if the density of gravity from all the mass in the universe was large enough, the universe would collapse into a dense ball, a singularity, called the big bounce. If the density of all the gravity in the universe was too small, the universe would expand forever. If the density of all the mass in the universe was just right, called the Goldilocks zone by physicists, the universe would be Einstein's static, general relativity universe – neither expanding nor contracting. But we know that the universe is expanding.

Something must be repelling the universe to expand more than the attractive force of gravity.[1366] Remember the Cosmic Microwave Background? It came from a NASA mission called WMAP or Wilkinson Microwave Anisotropy Probe. The probe was able to take a baby picture of the universe to finally answer the question about the density of matter in the universe.

> The WMAP science team has determined, to a high degree of accuracy and precision, not only the age of the universe, but also the density of atoms; the density of all other non-atomic matter; the epoch when the first stars started to shine; the "lumpiness" of the universe, and how that "lumpiness" depends on scale size. In short, when used alone (with no other measurements), WMAP observations have improved knowledge of these six numbers by a total factor of 68,000, thereby converting cosmology from a field of wild speculation to a precision science.[1367]

For flat geometry, all the angles in a triangle are equal to 180 degrees. For positive geometry all the angles in a triangle are more

than 180 degrees. For negative geometry all the angles in a triangle are less than 180 degrees. Here are the final results.

> Remarkably, WMAP's precision measurement of the properties of the fluctuations has confirmed specific predictions of the simplest version of inflation: the fluctuations follow a bell curve with the same properties across the sky, and there are equal numbers of hot and cold spots on the map. WMAP also confirms the predictions that the amplitude of the variations in the density of the universe on big scales should be slightly larger than smaller scales, and that the universe should obey the rules of Euclidean geometry so the sum of the interior angles of a triangle add to 180 degrees.[1368]

So, something must be missing since we know the universe is expanding. Here is what WMAP tells us,

> The universe comprises only 4.6% atoms. A much greater fraction, 24% of the universe, is a different kind of matter that has gravity but does not emit any light --- called "dark matter". The biggest fraction of the current composition of the universe, 71%, is a source of anti-gravity (sometimes called "dark energy") that is driving an acceleration of the expansion of the universe.[1369]

Remember that dark energy is repulsive. Since it appears that there were hidden valleys of dark matter, this dark matter would affect the overall mass density of the universe as repulsive. Additionally, the vacuum energy cannot be left out of this subject.

> When we considered whether the observable mass in the universe would be enough to render it flat or closed, we completely ignored the possibility of vacuum energy. That

would be a mistake in a world with a cosmological constant. Einstein's equations say that all forms of energy affect the curvature of space. Energy and mass are the same thing, so vacuum energy must be counted as part of the mass density of the universe. The ordinary and dark matter together add up to about 30 percent of the mass needed to flatten or close the universe. The obvious way out of the dilemma is to make up the missing 70 percent in the form of a cosmological constant. This would mean that the vacuum-energy density was a little more than twice the mass of ordinary and dark matter combined, about thirty proton masses per cubic meter.

Because the cosmological constant represents a repulsive force, it would have an effect on the way that the universe expands. The early phase of the expansion would not be much affected, but as the distance grows between galaxies, so too does the repulsive force. Eventually the cosmological constant can accelerate the outward motion of the galaxies, causing the Hubble expansion to pick up speed. 1370

For whatever reason, since the universe seems to be expanding, the overall cosmological constant of the universe appears to be negative. But on smaller scales we can find all three of these geometries in the universe in various degrees from very small to very large curvature. For Einstein, a blackhole had a flat geometry just like the static universe, neither expanding nor contracting, in his general relativity. However, using the most stable quantum physics which developed after Einstein and the latter discovery that the universe was expanding, it turns out that blackholes have a negative geometric curvature.1371

Quantum foam is addressed by the uncertainty of the quantum wave function which describes all currently known possibilities for how quanta can 'collapse' into reality. Under certain conditions such as a change in energy, the wave function might spontaneously

collapse without observation and a virtual particle will produce a subatomic particle. These subatomic particles can bond to become electrons, protons, neutrons, atoms, etc. and can account for three of the four known forces in the universe. The four known forces are the weak and strong forces of nuclear bonds, the electromagnetism force, and the force of gravity. Here is another thought, could it be that a singularity could be pure information which has no prior cause.

Quantum Gravity in Two and Three Dimensions of Blackholes

The event horizon is a two-dimensional surface created by, and as, the point where everything, all quanta, including light itself is lost to our universe. Yet a black hole also has massive gravity. Gravity exists in three dimensions. Both the two and three-dimensional aspects of a black hole represent information. Somehow, the physical existence of a black hole figures out how to combine both of these dimensions to create the black hole. This strange kind of information stores information which we think of as gravity **and** information at the event horizon entrance to the blackhole. At the two-dimensional surface of the event horizon, a particular kind of radioactive decay called "Hawking Radiation" could, over very large periods of time, release encoded information of what went into the blackhole back into the cosmos. Physicists think of this encoded information as not lost to oblivion but retained. This would fortify a long tradition in physics which states information can never be lost only transformed into other kinds of information. The dilemma of physics today is how to combine the three forces of nuclear strong and weak forces and electromagnetism with gravity. The black hole has found a way to combine all these forces and has already solved this dilemma by its very geometry. The solution to the black hole mystery would account for all forces in the known universe because it includes encoded information of all quanta and their forces which went into the event horizon **and** gravity. Another

way to articulate this is black holes solve the problem of the very small of quantum mechanics and the very large of gravity and spacetime.

Einstein's 1935 EPR Paper – Spooky-Action-at-a-Distance

As mentioned in 1935 the Einstein, Podolsky, and Rosen paper was published.[1372] Henceforth, I will call this the EPR paper. Though derived from Einstein's arguments, the text was actually penned by Podolsky, a fact Einstein later lamented. This paper examined the spooky phenomenon of quantum entanglement. Heisenberg and Bohr had shown the necessary uncertainty of measuring subatomic particles. Richard Feynman once said,

> "Quantum mechanics" is the description of the behavior of matter and light in all its details and, in particular, of the happenings on an atomic scale. Things on a very small scale behave like nothing that you have any direct experience about. They do not behave like waves, they do not behave like particles, they do not behave like clouds, or billiard balls, or weights on springs, or like anything that you have ever seen.[1373]

As mentioned earlier in the 'Complementarity' section it is impossible to measure the position and momentum of a subatomic particle at the same time. I used an analogy to illustrate this which referred to the moon and a mega planet to measure position and a pressure gauge to measure momentum. It illustrated how measuring one property prohibits being able to measure another property. This is known as the uncertainty principle. This makes it impossible to measure both position and momentum of the electron at the same time. This kind of problem applies to many kinds of measurement we are trying to make of subatomic particles. Measuring a subatomic particle changes the particle. Heisenberg once said,

> At the instant of time when the position is determined, that is, at the instant when the photon is scattered by the electron, the electron undergoes a discontinuous change in momentum. This change is the greater the smaller the wavelength of the light employed, i.e., the more exact the determination of the position. At the instant at which the position of the electron is known, its momentum therefore can be known only up to magnitudes which correspond to that discontinuous change; thus, the more precisely the position is determined, the less precisely the momentum is known, and conversely.[1374]

Heisenberg is not telling us that the change in momentum is uncertain. He is telling us that the size of the change in momentum is uncertain.

> Apparently, when Heisenberg refers to the uncertainty or imprecision of a quantity, he means that the value of this quantity cannot be given beforehand. In the sequence of measurements we have considered above, the uncertainty in the momentum after the measurement of position has occurred, refers to the idea that the value of the momentum is not fixed just before the final momentum measurement takes place. Once this measurement is performed, and reveals a value pf [final momentum], the uncertainty relation no longer holds; these values then belong to the past. Clearly, then, Heisenberg is concerned with unpredictability: the point is not that the momentum of a particle changes, due to a position measurement, but rather that it changes by an unpredictable amount. It is, however always possible to measure, and hence define, the size of this change in a subsequent measurement of the final momentum with arbitrary precision.[1375]

The result is that uncertainty is essential to experimental observation of any very small subatomic particle. However, there is a difference between the analogy I used about the moon and what Heisenberg tells us about uncertainty. In the analogy about the moon, it is easy to see how crashing a mega planet into the moon or having the moon collide into a giant pressure gauge would irrevocably disturb the moon and not allow any other measurements to be taken. The story is much spookier than that analogy leads one to believe. Heisenberg tells us that he believes the property, whether it is position or momentum, does not exist prior to the measurement. With regard to the path or position he tells us that measuring the property brings it into existence.

> I believe that one can formulate the emergence of the classical "path" of a particle succinctly as follows: the "path" comes into being only because we observe it.[1376]

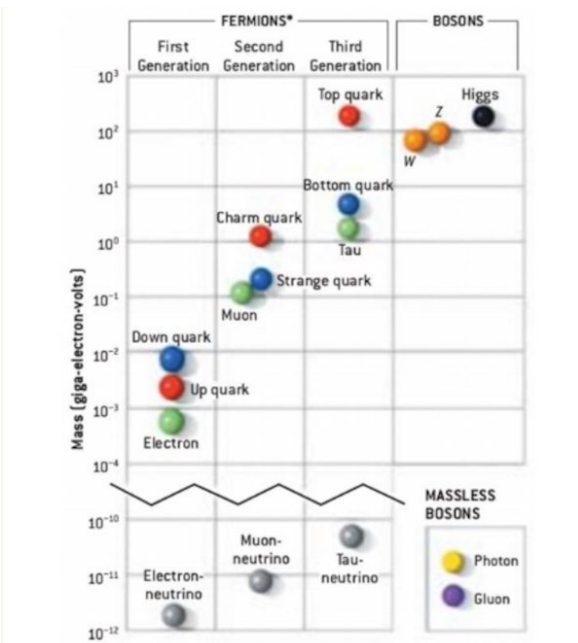
This kind of uncertainty is extremely different from classic physics which was completely deterministic. Classic physics assumed a measurement could never alter the phenomenon it was trying to measure. It would have been pure nonsense or alchemy to insist that a property did not exist until it was measured. The EPR paper questioned the idea that the position, linear momentum, and other properties of two quantum systems could be linked in such a way that spacetime would have nothing to do with how these properties were linked. Einstein thought that was plain spooky and there had to be local variables at work which would explain this uncertainty in ontic terms meaning something existed which would explain it.

The EPR paper not only discussed the position/momentum problem but also how systems could be separated in space and measuring one property would fix the property in the other system which was separated in space.[1377] A short time later that year Erwin Schrödinger called this odd behavior entanglement.

Entangled particles have nothing to do with their local environment. They can be separated by the distance of the universe and act ‘as if they were identical’ in their behavior. As was previously mentioned Einstein thought there must have been some kind of hidden local variables which accounted for this “spooky-action-at-a-distance”. Sadly, this was emphatically proven to be false in subsequent years.

Fermions and Bosons

Quantum mechanics' standard model is currently comprised of two categories of subatomic particles, fermions and bosons.



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Together these categories of particles show us how the forces of atoms create, sustain, decay, and destroy an atom. They also show

us a very odd phenomenological effect which happens all the time in atomic construction called entanglement. Bosons are force-carrier particles. Force is exchanged between particles when bosons are exchanged within the particles. In classic physics Newton was perplexed by something he termed “action-at-a-distance” referring to forces like gravity.[1379] He thought action at a distance was spooky and there must be something in the middle like billiard balls which transferred energy and momentum. Newton took a more theological approach to this ‘something’. However, if Newton would have understood an ancient Greek philosopher named Zeno, he would have understood that the billiard ball approach would have still assumed some unknown but increasingly smaller “action-at-a-distance” present between the billiard balls. In fact, there would have been infinitesimally smaller spaces such that one billiard ball could never reach the other billiard ball. This is called Zeno’s paradox.

In any case, the subatomic force that carries the strong force is the ‘gluon’. The electromagnetic force is carried by the ‘photon’. The ‘W’ and ‘Z’ bosons create the weak force. If the graviton is found, it will be the quanta responsible for gravity.[1380] Subatomic particles appear to be highly abundant in the universe and both free particles or bound particles go into making such things as protons, neutrons, and electrons. In either case, particles can be entangled with other subatomic particles that make them behave in identical ways without any influence at all by spacetime. Entangled particles can be separated by billions of light years and still behave with identical properties. Properties such as spin, angular momentum, etc. mimic each other instantaneously without any hint of space or time. Quantum entanglement can also be destroyed in which case no useful information can be ascertained about its previously entangled particle. Ah, but there is at least one study which shows that it may be possible for previously entangled particles to be ‘reborn’.[1381] Let’s discuss the relation between energy, heat, and work.

Heat is frenetic nuclear activity. All matter on the smallest levels jitters randomly. This is a form of noise. To the extent that a system has random activity means no useful information can be found. However, energy is not absolutely random energy. We can find useful information from energy. Some forms of energy can be kinetic and potential. Aristotle thought of kinetic energy as motion which was actual or existent. He thought of potential energy as a possibility which was unreal or non-existent. In current physics kinetic energy is associated with motion and potential energy is stored energy from position or state. The more heat we have, random energy, the less work can be achieved.

Potential and kinetic energy applies to all forces. As mentioned, potential energy is energy capacity given to some phenomenon by position or state. Kinetic energy is energy associated with the motion of a phenomenon. There is a kind of seesaw effect of these two types of energy. Potential energy can propel or attract. Two magnets brought close to each other encounter a potential energy field which either propels or attracts kinetically depending on which poles of the magnet are facing each other. In bringing two magnets close together kinetic energy must be applied to one of the magnets. An object floating in space follows the path of least resistance due to the potential energy of the spacetime curve of its path. If thrust is applied kinetic energy can cause a spaceship to resist the potential path of least resistance and change orbits. Potential and kinetic energy have to do with the environment of a phenomenon and the motion of a phenomenon respectively. There is always a push/pull between the two types of forces even on subatomic levels. Potential differences can cause major, unexpected changes which alter even the physics of time and space. Early on in cosmology the inflationary expansion of the universe expanded the universe 10^{26} times its size in 10^{-36} seconds. This was much faster than the speed of light. This could happen because matter and

radiation had not found an equilibrium yet and light could not travel in a transparent universe because the universe was opaque. Without inflation, the age of the universe would be too short to explain how the universe is the way it is today in terms of homogeneity, its amount of same 'stuff everywhere', and isotropies, the same properties in all directions.

> The situation is quite different in the big bang model without inflation, because gravitational expansion does not give the early universe enough time to equilibrate. In a big bang with only the matter and radiation known in the Standard Model, two widely separated regions of the observable universe cannot have equilibrated because they move apart from each other faster than the speed of light and thus have never come into causal contact. In the early Universe, it was not possible to send a light signal between the two regions.[1382]

It is believed inflation started somewhere between 10^{-32} seconds and 10^{-33} seconds. This event was the work of potential energy in the very early universe. Physicists call this event a metastable state. Much more on metastable states later.

Thermal equilibrium happens when two systems which have different temperatures are combined resulting in the equalization of their temperatures. Here are the four simplified laws of thermodynamics:[1383]

> The Zeroth Law of Thermodynamics:
>
> If two bodies are each in thermal equilibrium with a third body, then they are also in thermal equilibrium with each other.
>
> The First Law of Thermodynamics:
>
> The change in a system's energy during a thermodynamic process equals the heat added to the system, minus the work it performs on its environment. In differential form, this is

written as $dE = dQ - dW$ where d represents the change in E, Q and W. E represents energy, Q represents heat, and W represents work.

The Second Law of Thermodynamics:

In any thermodynamic process, the total entropy either increases or remains constant, but never decreases, or Heat will never spontaneously flow from a colder body to a warmer one.

The Third Law of Thermodynamics:

As the temperature of any system approaches zero, its entropy approaches a minimum value. 1384

From the first law we can see that the amount of work possible is dependent on the difference between heat and energy or useless information and useful information. Another way to say this is the more heat we have in an isolated system, the less work we can do. All matter in the universe has a certain amount of random kinetic jitter and frenetic chaos. Kinetic (Greek *kinêsis*) here can refer to Aristotle's notion of actuality. Heat is entropic meaning it is the molecular measure of a system's inability to do work. We call this measure entropy. Entropy is the return to chaos.

The Nether Land of Semiclassical

But let's put all this in perspective from the vantage point of the quantum wave function. Nothing we think of as physical exists in the wave function, including and most importantly existence itself. Thermodynamics is the dynamics of physical heat. Heat does not exist in the quantum wave function. Potential and kinetic energy is physical energy. Energy does not exist in the quantum wave function. Entropy is a measure of the unavailability of heat to do work. The arrow of entropy and even time in our experience of the universe always moves from more availability to do work to less availability to do work. Ironic that even our lifetime moves from

more time to less time. But entropy and even space and time as physical do not exist in the quantum wave function. However, all physicality has some spooky relationship to aspects of the quantum wave function. But there are semiclassical components in the quantum wave function which have a hazy relationship with what we perceive as physicality.

In the context of quantum mechanics, the concept of energy is intricately tied to the wave function. The Schrödinger equation describes the behavior of quantum systems. It is a linear partial differential equation that governs the wave function (denoted as Ψ) of a quantum-mechanical system. Conceptually, the Schrödinger equation is analogous to Newton's second law in classical mechanics. While Newton's second law predicts the path a physical system will take over time, the Schrödinger equation shows the evolution of the wave function. Louis de Broglie's postulate suggests that all matter has an associated matter wave. The wave function provides information about the behavior of particles, including their energy states. The energy of a particle in the wave function has contributions from both kinetic energy (related to momentum) and potential energy (associated with the environment or potential field). The wave function itself encodes **information** about the probability distribution of a particle's position in space. The square of the wave function represents the probability density of finding the particle at a specific point. The energy eigenstates (stationary states) correspond to specific solutions of the Schrödinger equation, where the wave function remains unchanged over time. These energy eigenstates are associated with quantized energy levels, and the wave function provides insights into the allowed energy states of the system. Quantum mechanics offers various formulations, including matrix mechanics and the path integral formulation. When comparing these approaches, the Schrödinger equation is sometimes referred to as "wave mechanics." Paul Dirac's formulation incorporates special relativity and simplifies the Schrödinger equation when relativistic effects are negligible. The

wave function not only describes the behavior of quantum particles but also provides information about their energy states. Understanding the wave function allows us to explore the probabilistic nature of quantum systems and predict their behavior. 1385

Entropy is a measure of disorder, randomness, or unpredictability in a system. In classical thermodynamics, entropy is associated with the number of microscopic states (microstates) consistent with a given macroscopic state (macrostate). For example, consider a gas in a container. The microstate describes the positions and momenta of all its atoms. Although individual atom motions are chaotic, the overall behavior of the gas is predictable due to the large number of atoms. Entropy quantifies the multiplicity of microstates that correspond to the same macrostate. Boltzmann's definition relates entropy to the logarithm of the number of accessible microstates. In quantum mechanics, entropy is not directly observable as a physical quantity. However, it is associated with the density matrix (or quantum state) of a system. The von Neumann entropy is an extension of classical entropy to quantum systems. It characterizes the uncertainty or mixedness of a quantum state. The von Neumann entropy reflects the distribution of probabilities among the system's energy levels or eigenstates. The wave function (denoted as Ψ) encodes information about the behavior of quantum particles. When a quantum system undergoes a wavefunction collapse, its entropy can change. Collapse introduces an additional microstate (e.g., a photon emitted or absorbed), altering the statistical entropy. However, entropy is not well-defined for a single particle; it emerges when considering ensembles of particles. The wave function itself represents a superposition of different eigenstates, which can be thought of as "entangled" in terms of their probabilities. Quantum relative entropy measures the distinguishability between two quantum states. It quantifies how different two density matrices are. It is analogous to classical relative entropy but adapted to the quantum

realm. While entropy is not directly observable for individual particles, it plays a crucial role in understanding the probabilistic behavior of quantum systems. The interplay between wave functions, quantum states, and entropy reveals the intriguing and spooky intricacies of the quantum world. Even more, quantum entanglement and entropy have some interesting semiclassical relationships. 1386

Quantum entanglement and entropy share a profound semiclassical connection to quantum mechanics. As we have found, entanglement is a phenomenon where two or more quantum particles become inextricably linked, even when separated by large distances. When particles are entangled, their properties become correlated, and measuring one particle instantly influences the other, regardless of the spatial separation. Entanglement defies classical intuition and plays a central role in quantum theory. Entropy measures the degree of disorder or randomness in a system. In the context of quantum entanglement, entropy provides insights into the information content and mixedness of quantum states. Specifically, let's look at the concept of entanglement entropy. Consider a composite quantum system consisting of two subsystems (particles) that are entangled. The entanglement entropy quantifies the entanglement between these subsystems. Mathematically, it is defined using the reduced density matrix of one of the subsystems. High entanglement entropy indicates strong entanglement between the subsystems. When the entanglement entropy is maximal, the subsystems are maximally entangled. Conversely, if the entanglement entropy is zero, the subsystems are not entangled (they are in a separable state). Quantum information theory exploits entanglement for tasks like quantum teleportation, quantum cryptography, and quantum computing. Quantum phase transitions are associated with changes in entanglement entropy. In many physical systems, the entanglement entropy scales with the boundary area between subsystems rather than their volume. The quantum Zeno effect relates to entanglement and measurement.

Frequent measurements can stabilize a quantum system, preventing it from evolving.

> The source of the quantum Zeno effect lies in the mathematical fact that for a system to evolve under Schrödinger evolution from some initial eigenstate of an operator to some other eigenstate of that operator, it must evolve through superpositions of eigenstates. Eigenstates are orthogonal to each other, so the continuous process of Schrödinger evolution cannot evolve directly from eigenstate to eigenstate. If a system governed by this process cannot pass through superpositions of these eigenstates, then the system cannot change from one eigenstate to another. Another way to put things is that if small superpositions are permitted, an initial superposition will assign probability 1-ϵ (where ϵ is negligible) to the initial eigenstate. So if there is a measurement of this observable in the first moment, the superposition will collapse to the initial eigenstate with probability 1- ϵ. Continuous measurement will therefore force the system to remain in that initial eigenstate. 1387

In the context of entanglement, the quantum Zeno effect can influence the entanglement entropy. Entanglement entropy provides a window into entangled particles. It reveals the hidden connections and information-sharing between subsystems, making it a crucial aspect of quantum mechanics. 1388

Entropy is a measure of uncertainty in a system or the loss of useful information. Perhaps, we could think of heat as *a priori* return to the origin or what we now call ‘the Big Bang’. If so, Hesiod’s commonly understood observation that before the gods there was chaos might have been ahead of its time. Entropy is ultimately disorder which ends when order ends and results in pure entangled chaos. Heat is simply degrees of random behavior until pure chaos is achieved as in the heat death of the universe. We

might think of the heat death of the universe as really cold but a better way to think about is that no variations of heat are available to perform useful work. There are no possibilities for thermal equilibrium to occur. Information can no longer support any sense of cause and effect or spacetime because it is too random and chaotic. Nothing exists in chaos. Pure chaos here means 'actual' information is not retained in a useful way. Perhaps another way to think of this is all possible information is retained a-causally as purely potential, with absolutely no way of 'becoming' actual.

Entanglement complexity is related to high degrees of entropy in a system. But let's suppose the system is the universe. For the universe entanglement complexity is maximal. Therefore, entropy is maximal. However, this is not a linear scale where the maximal can keep getting to higher levels. What actually happens is that complexity reaches a limit that we think of as chaos. The universe and the quantum wave function complexity asymptotically approach the limit of chaos. What is past that limit is spooky incomprehensibility. Think about the speed of light. The speed of light is an asymptotic limit in the universe which distorts time and space. But what is beyond the speed of light? Nothing to do with speed but everything to do with spooky entanglement. As we know exformation has nothing to do with time or space in terms of instantaneous information which is irrelevant to the speed of light in our classical universe. Would it be too much to assume that beyond the asymptotic limit of chaos is the simultaneity of the universal[1389] wave function? This vacates the thought of complexity's limit and is an excess to some kind of classical notion of "absolute complexity". Why? Because it does not lapse into a binary duality, an either chaos or order. Chaos spookily is both classical notion of absolute chaos and absolute order and more importantly, exceeds infinitely both classical notions.

Cause and effect, change, existence, time, and space cannot, in any sense of the word, 'be' pure chaos. The notion of pure chaos is only applicable to the nether land of what is 'not' AND neither is it

that ‘not’. As mentioned, Aristotle referred to this as potential (Greek: *dunamis*). Aristotle tells us that a thing that exists potentially does not exist but makes possible what does exist. For Aristotle, actuality (Greek: *entelecheia*) or activity (Greek: entelecheia) is the effect which moves forward from the cause, potential. Potential here meaning *telos* or the final goal, completion, fulfillment. In Aristotle’s work “Metaphysics Z” he deals primarily with these notions.

> Aristotle distinguishes between two different senses of the term dunamis. In the strictest sense, a dunamis is the power that a thing has to produce a change. A thing has a dunamis in this sense when it has within it “a starting-point of change in another thing or in itself insofar as it is other”. The exercise of such a power is a kinêsis—a movement or process. So, for example, the housebuilder’s craft is a power whose exercise is the process of housebuilding. But there is a second sense of dunamis—and it is the one in which Aristotle is mainly interested—that might be better translated as ‘potentiality’. For, as Aristotle tells us, in this sense dunamis is related not to movement (kinêsis) but to activity (energeia). A dunamis in this sense is not a thing’s power to produce a change but rather its capacity to be in a different and more completed state. Aristotle thinks that potentiality so understood is indefinable, claiming that the general idea can be grasped from a consideration of cases. Activity is to potentiality, Aristotle tells us, as “what is awake is in relation to what is asleep, and what is seeing is in relation to what has its eyes closed but has sight, and what has been shaped out of the matter is in relation to the matter”.[1390]

Exformation cannot be caused by anything, but it finds actuality as statistical predictability. This certainly sounds like yet another case of complementarity. Exformation has a dual nature in effect.

We can observe its effects in entanglement, its actuality, which we think of as form, order, existence, etc. Exformation can at times predict statistically certain outcomes upon observation given certain prior decisions about the conditions of experimentation. But by 'prior [experimental] conditions' we know from previous discussions that we are not thinking prior 'reality' but the state of superposition. However, this will always be an unsolvable enigma, an alien capacity which resists classic formulations in science and philosophy. It should also be noted that information theory is also an area of physics, math and computer science which informs us how to deal with highly complex systems. As such, exformation is a newcomer to information theory. It finds many useful applications in information theory one important example being quantum computing. Is time and space emergent from exformation?

Spacetime Emergent from Quantum Entanglement

Let's recall that a fundamental tenet of classical physics is that all objects are completely localizable as definite places and times. As mentioned, even Einstein believed that local variables would eventually explain quantum entanglement, but it didn't. In fact, it proved the opposite, that quantum entanglement had nothing essential to do with locality.

For hundreds of years, classicism has scientifically structured itself upon forces and interactions which simply assume locality. Initially, absolute locations and speeds of *objects* were taken up by classicism for hundreds of years. Even Einstein's relativity simply changed the grid upon which locations and speeds were relativized. The absolute no longer prevailed as God or objects in increments of distance and time. The absolute became the speed of light. So, causality was no longer linear and equal increments of time but curved and distorted relative to the speed of light. But causality was preserved. Classicism was made relative to the absolute – light. We moved from linear causality to curved and relative causality. Time

could move forward and backward as one more dimension of the same type as distance in three dimensions. But the same genius which moved us into relative causality also broke relative causality. At first, he railed at "spooky action at a distance" but failed with decades of trying to localize this spook. Distance and time failed the spook test. Now we know that the spook is not little, marginal, and so tiny we can simply ignore it. We know that the spook is not "*one but rather **the** characteristic trait of quantum mechanics, the one that enforces its entire departure from classical lines of thought.*" [1391] Entanglement defies size which harkens back to distance. Entanglement is pervasive from the smallest quark to the largest universe. Singularity may not have happened way back when…it may still be happening!

When entangled particles or systems cohere, they behave as identical particles which have no dependence on space and time. When they cohere, they are only exformation which has the quality of behavioral identity. Coherence encodes exformation which is not dependent on spacetime. It is not local in any conventional sense of the word. Neither is it conditioned by time. Some physicists believe that time and space are emergent from entanglement.

If time and space are emergent, this could account for an information theory which is atemporal and aspatial which we call exformation. That is, entanglement is not dependent on time and space but rather, creates time and space. It may well be that the universe arises from exformation. If so, cause and effect make no sense except as a by-product of spacetime which is itself emergent from exformation.[1392] If this is true, it would seem to make sense that empty space would not really be empty but stitched together by entangled particles.

There is mounting evidence that the empty vacuum of spacetime is actually stitched together by entanglement. Even if we were to take away virtual particles popping in and out of existence from vacuum energy there are still electromagnetic fields. Photons propagate through these fields. The actual stitches of entangled

spacetime jiggle randomly. If you divide any two regions of empty space, the amount of entanglement is correlated to the area of the interface created by the divide.

> Even in a vacuum, with no particles around, the electromagnetic and other fields are internally entangled. If you measure a field at two different spots, your readings will jiggle in a random but coordinated way. And if you divide a region in two, the pieces will be correlated, with the degree of correlation depending on the only geometric quantity they have in common: the area of their interface. In 1995 Jacobson argued that entanglement provides a link between the presence of matter and the geometry of spacetime—which is to say, it might explain the law of gravity. "More entanglement implies weaker gravity—that is, stiffer spacetime," he says.[1393]

What is interesting here is that less spacetime curvature seems to have a relationship with more entangled density. The contrary is also true, less density of entanglement seems to imply more spacetime curvature. If this is true, then when spacetime is stretched due to inertial mass, entangled particles may be less dense or what we 'think' of as stretched farther away. Another way to say 'less vacuum space' might be to say less entangled density. Thus, as inertial mass stretches spacetime, it results in more spacetime curvature and less entangled density in the fabric of empty space. It seems that like a rubber band, black holes may stretch the fabric of spacetime with less entangled density so far that spacetime actually 'pops' and swallows up any and all entangled densities around it. In any case, if we have two entangled systems, there will be a degree of decoherence between the two systems. The degree of decoherence can be thought of as a kind of entropy between the two systems implying that meaningful information between the two systems is limited by more entangled entropy, less entangled

density. Entangled entropy may also indicate that the coherence between the two systems might be limited by other entangled systems.

This study published in 2021 postulates this point,

> The concept of entanglement entropy aims to quantify the uncertainty arising from a quantum (sub)system's lack of a definite quantum state, due to it being possibly entangled with another (sub)system.[1394]

As far back as 2003 and in a paper published in 2006 [1395] Fotini Markopoulou proposed that gravity itself is a result of "pre-spacetime quantum theory". In this paper she notes that quantum interactions of these excitations are how we understand spacetime. In one fell swoop she dismantled relativistic causality. We currently know much more along these lines in which she pioneered. Our brains as historic abodes of language have accustomed us to thinking spacetime in terms of locality.

An article in Scientific America [1396] reports that the intuitive ideas we have like causality involves objects in physical proximity to each other will soon become more like what I refer to as antiquated old tales we tell ourselves over and over again as if it were divine truth. From earlier in the book remember the sad tale that, "Beer drinkers all over the world were crying in their beer when their pee was not found to be the source of all light." The article's author believes that locality is one of those myths. Perhaps, as I discussed entangled density will be what gives us a notion of nearness and farness. The author believes that averaging over fundamental processes (e.g., quantum entanglement) involves a "myriads of individual events". Might we think of exformation and information theory? Could we go so far as to wonder about quantum chaos and its role in everything we think of as world and us? The author indicates that "it is inevitable that locality will be disordered".

I prefer chaos as I have written, as excess to the term disorder which to me denotes the legacy of classicism. Insightfully, the author indicates to me that the way we marginalize entanglement as some rare kind of event has not yet been penetrated by popular culture what physicists have known for almost a hundred years. As Schrödinger wrote in 1935, "*I would not call [entanglement] one but rather* ***the*** *characteristic trait of quantum mechanics, the one that enforces its entire departure from classical lines of thought.*" 1397 Even many academic philosophers are still ruminating in classical lines of inquiry. This book has been an attempt to try to bring forward the inevitable which awaits us if we can survive long enough. What we think as the universe, me here now, is on the brink of an abyss which is not diminutive but expansive and liberating beyond belief, infinitely more expansive than the small and ever more constricting lived, historic spaces which have outlived their usefulness.

Physics research and philosophy have shown us radically other avenues from

1. entangled density to
2. scars or residues of wave function collapse, novelties which must join the wave function as new degrees of freedom, patterns which move toward 'natural' selection in wave function decoherence to
3. quantum chaos which makes the entire universe one among infinites of possibilities/realities to
4. an excess in which we can only marvel at and in responsibility. 1398

If we peer into the void and the void stares back, there is no reason for alarm but every reason for hope and astonishment of who stands before us. Death itself pales in the face of, what shall we call it, none other than radical exteriority in the face of the other. This is not God but he, she, or whatever pronoun you choose. We have yet to learn what awaits us. Our only task is to grow outside

ourselves, outside Narcissuses, outside the echo of ourselves to ourselves...and face responsibility.

This is a wild speculation on my part but what if the stretch in spacetime, less entanglement in spacetime vacuum implies more entangled gravitons? What about blackholes? Obviously blackholes have a lot of gravity or spacetime curvature. How would entanglement work for a blackhole?

Spacetime and Quantum Entanglement in the Blackhole

There are interesting similarities between a blackhole and our expanding universe. First, let's think in terms of special relativity which deals with how the speed of light affects everything in the universe. In our expanding universe a kind of event horizon is formed due to the speed of light. If we are thinking about what we can see with the most powerful space telescope we could ever devise, we would never be able to see further than it would take photons traveling at the speed of light to get to us. This is called the observable, visible, or causal universe. However, the universe could be much larger or infinitely large as far as we know but because in principle, due to the speed of light, we will never see it or directly detect its causal effects on us. This larger universe is called the cosmological universe.

> The word observable in this sense does not refer to the capability of modern technology to detect light or other information from an object, or whether there is anything to be detected. It refers to the physical limit created by the speed of light itself.[1399]

There is also another limit called the particle horizon of the universe. The particle horizon is the maximum distance any particle could have traveled at the speed of light to have reached us. This assumes something called conformal time. Conformal time is not

'real'. It is hypothetical. This hypothetical time has three hypothetical assumptions:

- It is the furthest distance a photon could travel at the speed of light if we released it now relative to our frame of reference.
- It assumes the universe stopped expanding now.
- It also assumes that the universe will never stop expanding. [1400]

We know conformal time would be a finite distance the particle could travel going at a constant speed, the speed of light relative to our frame of reference. Remember as a massless particle a photon would never see our universe from its relative perspective. The idea here is that there is a point where anything and everything would simply vanish, have no possibility for interacting with our region of the universe.[1401] Another limit is called the informational limit of the universe. As I have mentioned, and will discuss later as well, entropy can be thought of in terms of information.

> Entropy is measurable in bits, if considered as information.[1402]

There is a limit to how much information can be stored in our universe depending on a few very basic physical constants in our universe. Namely, the speed of light 'c', the quantum scale or Planck's constant 'h', and the gravitational constant 'G'.[1403] This works out to 10^{123} bits of information is the maximum amount of information that our current universe could contain.[1404] There is also a very fascinating mathematical fact for physicists which came out of calculus and holographic mathematics which in itself has nothing necessarily to do with blackholes or anything physical since it is purely mathematical: You can take any volume you want and its volumetric capacity will be limited by its surface area. Any

volume has a surface no matter how many dimensions you care to make it. A sphere has a ball-like shell as a boundary, or you can take any complex geometric object and compute its maximum volume just from the surface area. This is called the surface-area-to-volume ratio.

> SA:V [surface-area-to-volume] is an important concept in science and engineering. It is used to explain the relation between structure and function in processes occurring through the surface and the volume. Good examples for such processes are processes governed by the heat equation, that is, diffusion and heat transfer by thermal conduction. SA:V is used to explain the diffusion of small molecules, like oxygen and carbon dioxide between air, blood and cells, water loss by animals,[4] bacterial morphogenesis, organism's thermoregulation,[6] design of artificial bone tissue, artificial lungs and many more biological and biotechnological structures.[1405]

So, for example, from knowing the surface area of the event horizon of a blackhole we can compute how much stuff, even information or more specifically exformation, it can hold in its volume. This is why physicists think there is a finite limit to how much stuff can fall into a blackhole before no more can go in. Over long periods of time, all the information that went in will evaporate out. So, no matter how you slice it, there are limits to observation, particle horizon, and information. These limits can be visualized as an event horizon of a blackhole.

Other kinds of limits do not have to be thought of as a hard boundary as the flat-earthers would think of as if you could simply hit a limit where, one more step, and you fall off the face of the earth. The speed of light is an example of an infinite limit. This does not mean light could travel at infinite miles per hour. It means, if you have mass, as you approach the speed of light you never

actually get to the speed of light. As in calculus, you approach a limit but if you spin all the numbers out to infinity you still keep missing the limit by infinitesimally smaller amounts never to arrive at the exact limit number. Zero degrees Kelvin is another example of an infinite limit you never actually hit. However, just because you never hit that number, you might be able to discontinuously jump over it by changing the physical laws which defined that limit. We will see this a little later when we talk about metastable environments. In a blackhole, the event horizon is an exit ramp from our universe which marks the place where the speed limit of light no longer applies. This may not mean 'faster than the speed of light'. It could mean that the laws of physics in our universe no longer apply for some reason. The event horizon of a blackhole is a kind of metastable event. It *may* be that the speed of light is exceeded or some other physical constraint in our universe no longer applies. In any case, the universe's event horizon, it's limit, can be visualized as a boat in the middle of the ocean with no land in sight. We see an enclosed horizontal circle all around us which we call a 'event horizon'. However, if we lived and existed in this boat world, we may start looking that the currents and start to formulate what kind of structures we cannot see which may cause the motion of the currents over time that we do see. We may even formulate laws which explain the odd fluid-like dynamics we have observed over the years. We may even come up with some metaphysical concept called 'land' which actually would be a useful way to think about the cause for the current's ceaseless motion.

To tie this back in to our accelerating universe, once we add in our expanding, accelerating universe and the limits it imposes like the speed of light, we may never be able to establish any causal relationship to anything beyond the horizon[1406] but we may be able to find effects, like some physical conditions of elementary particles behavior, which can only be explained indirectly with math or multi-dimensional geometry which we will never be able to directly 'see'. We might never be able to find direct causal links to explain

certain odd behaviors of elementary particles. These effects exceed our physics, our ‘laws of physics’ like why gravity or spacetime curvature does not seem to affect elementary particles at all. There are also macroscopic phenomena which we cannot explain using known ‘laws of physics’ like the blackhole or entanglement. However, we still may be able to ascertain what could be outside the observable universe by any effects or remnants which give us clues that something happened or is happening which may give a sufficient explanation for the effect we see. One example of this may be Planck sized, compacted dimensions of space which could still have real effects on elementary particle’s behavior in our causal universe. Remember point-like hadrons in which string theory was initially invented to explain its odd rubber band-like property. It still explains the behavior in terms of the mathematical geometry of compacted dimensions.

We can call the ‘event horizon’ of the universe the observable, visible, causal, particle, or conformal limit. From our moving region in spacetime there are other regions which we can never have any causal relationship in our part of the universe because it would take moving faster than the speed of light to gain any causal sense or relevant information of whatever is beyond these limits imposed by the speed of light. Even particles cannot travel faster than the speed of light so anything that would require longer than the speed of light to reach us will never have any effect on part of the universe. The cosmological idea of the causal universe draws from general relativity. But quantum physics offers a very different idea from classical history including classical relativity of a causal universe.

What most folks who have heard of string theory think is that it involves more than four dimensions abstract and perhaps bordering on metaphysical ‘theory’. But not so, even for relativity. I want to briefly highlight some of these divergences now. In relativity we think of spacetime as four-dimensional.

Contrary to popular belief, he did not draw the conclusion

> that space and time could be seen as components of a single four-dimensional spacetime fabric. That insight came from Hermann Minkowski (1864-1909), who announced it in a 1908 colloquium with the dramatic words: "Henceforth space by itself, and time by itself, are doomed to fade away into mere shadows, and only a kind of union of the two will preserve an independent reality"…
>
> Einstein initially dismissed Minkowski's four-dimensional interpretation of his theory as "superfluous learnedness" (Abraham Pais, Subtle is the Lord..., 1982). To his credit, however, he changed his mind quickly. The language of spacetime (known technically as tensor mathematics) proved to be essential in deriving his theory of general relativity.[1407]

Ever since Einstein, relativistic mathematics is not strictly four dimensional. One example of this is tensor networks which are used extensively in general relativity and quantum physics.

> You may have heard about tensors in connection to general relativity where they are used to describe spacetime. But tensors have also found their way into the realm of quantum many-body problems through tensor networks. Tensor networks (TN) are mathematical representations of quantum many-body states based on their entanglement structure. [1408]

Because tensor networks model entangled behavior they are very useful in describing something called emergence. Emergence is one of the most beautiful aspects of quantum behavior. It would be a mistake to think of emergence as cause or reason for something novel. This notion relies on the old classical metaphysics of yesteryear. Emergence is novelty in the strictest sense. In other words, emergent behavior is not tied to any past which preceded it. Does this ring any bells? Yes, quantum behavior and the spooky business of entanglement. And this is what tensor networks are all

about.

> A tensor network is a mathematical tool used to study the ways that many small objects in a system, such as its particles, combine and behave en masse. This "emergence" of collective behaviour is not just found in physics: everything from ecology to economics grapples with it. (You can see it in droplets of water that create a wave, or the emergence of counter-intuitive behaviours in topological insulators.)[1409]

Without tensor networks the mathematics of quantum physics is much more cumbersome and complex.

> The problem is, probability distributions and wave functions can be incredibly complex. For very small systems, the math is manageable. As your system gets larger, however, the computational effort to work out the probability distribution or wave function increases exponentially. A system doesn't have to be very large before it becomes too difficult for computers to manage. That's where tensor networks come in. They can extract the relevant information from a compressed model in order to "zoom out" and see the collective, or "emergent," behaviour. This offers an efficient way to codify complex structures.[1410]

But here is the problem, tensor networks work well on two-dimensions and even one-dimension but having them work well in three-dimensions is the problem.

> What makes them so helpful is that they provide a visual language, and accompanying set of mathematical tools, that simplify fiendishly difficult calculations. But there is a problem: tensor network algorithms currently only work really well for two-dimensional classical models, and by

extension, one-dimensional quantum models.

The main issue is computational. Pushing today's best tensor network algorithms to work in an additional dimension would require more computing power than currently exists. Still, that didn't stop three Perimeter PhD students from trying to do just that.[1411]

Symmetry vector fields find extensive application in the study of exact solutions in general relativity and the set of all such vector fields usually forms a finite-dimensional Lie algebra.[1412]

Mathematics has been using n-dimensional mathematics for centuries to explain certain kinds of geometry and behavior. Lie algebra is another part of general relativity which uses other dimensions besides four. Lie algebra can be more or less dimensions than four and can even be infinitely dimensional.[1413] Quantum physics' mathematics long ago made peace with many dimensions beyond four such as string theory which is still in use today. So, the speed of light is certainly essential to relativity but has a hazier relationship to quantum mechanics. One example of this is virtual particles.

Virtual particles are the hazy middle of ontology, between existence and nonexistence, and epistemology, as unknowable but necessary.[1414] Quantum physicists no longer need to find agreement with classical metaphysics or the lifting up of oppositions to a higher order to adhere to the final validation of truth or God found in many classical physicists including Newton. While there is nothing in our historical notion of special relativity faster than the speed of light, we know that there can be plenty which is incommensurate with the speed of light like exformation for example. Therefore, while the causal universe may be limited to a certain narrative of general relativity and the speed of light, quantum physics in many cases diverged long ago from the need to synchronize itself to general relativity.

Quantum gravity and quantum field theory try to resolve some of difficulties from relativity, but it appears that when all is said and done general relativity and quantum physics live alongside each other as complementarity, irreconcilable differences, which need pay no historic or metaphysical homage to each other. One example, the notions of locality, near and far, in general relativity are continuous and smooth space and time shaped by the speed of light. Quantum physics has no continuous near and far, no smooth transitions of temporality. The most intriguing and difficult question of quantum physics is how to explain temporality. But there is one indirect way, in the time evolution operator of Schrödinger's quantum wave function. Many of the greatest minds in the history of science were inevitably and even begrudgingly at times brought to the quite bizarre conclusion, even much spookier than Einstein's ghost, that the **only possible** solution to temporality is Schrödinger's cat, the infinite branching of the collapse of superposition, the simultaneity of many-worlds. More on that later.

When we think of photons passing through vacuum energy popping in and out of existence as they travel instantly through the universe, we developed the concept of virtual particles which is highly mathematical to explain the odd behavior. There is nothing intuitive about virtual particles, but it does provide a mathematical explanation. Moreso, while physicists tell us according to Einstein's relativity, gravity's range is infinite. It seems that if gravitons exist, they will find a limit in gravity's relativistic range due to the speed of light and our reference frame. This means any spacetime curvature or gravity beyond the limit of the particle horizon would never affect us. However, what addresses the concern of general relativity with its foundation in infinite limits is: How does the surface area boundary of the universe whether it is the observable universe, the particle horizon, or the information limit, affect the interior volume our universe? Also, what possible exteriority could explain odd and spooky behavior of our known interiority? As we have seen, other dimensions besides four are not nearly as big a

problem for general relativity or quantum physics.

If the universe is a hologram, as I mentioned earlier and will discuss more later, with two-dimensional Conformal Field Theory (CFT) and three-dimensional anti-de Sitter space (AdS), the extra third dimension would be encoded by Conformal Field Theory in the two-dimensional event horizon of the universe. The blackhole is also believed to be a hologram where the event horizon of the blackhole, described by two-dimensional CFT, encodes the three-dimensional, interior volume of the blackhole described by AdS space. Current thinking in physics is that while the lifetime of the blackhole is very long, the blackhole will reach a point where no more matter can occupy the volume of the blackhole due to the event horizon surface and the matter will begin to leak out until eventually the blackhole dissipates. Physicists believe that information is preserved in the blackhole. The coded information between the two-dimensional surface and the three-dimensional interior would be accomplished with entangled particles. Effectively, this might imply a relationship the two-dimensional (CFT) event horizon of a blackhole has with its three-dimensional (AdS) interior singularity. There are three leading ideas, not necessarily exclusive, about how information is preserved in the blackhole.

- Information could leak out through Hawking Radiation over the lifetime of the blackhole.
- Information could be encoded in the event horizon.
- Information could matriculate out when the blackhole starts to evaporate halfway through its lifespan. [1415]

All three ideas could work in tandem or separately or combinations of them. Hawking radiation is highly chaotic information which means it has a high degree of entropy. The encoded, exformation leaking out as Hawking Radiation evaporating out, stored in the event horizon, and/or evaporating

out over the blackhole's lifetime would prevent information from being destroyed. However, whatever mass or quantum particles fell into the blackhole would forever leave the universe. Only exformation would leave a trace of its eternally forgotten twin. Encoded information which fell in from our universe could never return to our universe as the 'stuff' or matter it was. However, this information could and would continue to cohere and decohere with other entangled systems. Why is the idea that no information can be lost so important to physicists?

Symmetry and Spontaneous Symmetry Breaking

Classical science was prefigured by a sacred devotion to symmetry, order, and balance. The ideals nourished the beginnings of science in the West and constituted the paradigm of truth throughout the ages culminating in modernism. Even Einstein's relativity is truly a beautiful example of symmetry in physics and highly accurate. There is no doubt that symmetry arises in physics but how it arises has been put into question by quantum physics and quantum gravity. Science has evolved through a process of better and better understanding of physics. But through much of this progress the underlying constitution of its truth has been based on and validated by more nuanced understandings of symmetry. Even today, the coupling of relativity and quantum field theory has been a powerful case for the 'spookiness' of quantum mechanics. However, the deeper we peer into our symmetries the more it becomes obvious that to a certain extent we are looking at our own face in the certainties of symmetry.

Diffeomorphisms correspond directly to spacetime symmetries. In general relativity, diffeomorphism invariance is essential. It ensures that the theory remains invariant under coordinate changes (reparameterizations) of the spacetime manifold. One example from quantum gravity is how the asymptotically flat, anti-de-Sitter (AdS) spacetimes can be enhanced to include infinite dimensions to agree

with relativity's spacetimes.

We have already seen how the fall into classicism from the wave function breaks the symmetry of superposition – its unitarity vis-à-vis state reduction from the observer effect. As physics peers deeper and deeper into gravity, spacetime curvature, and its relation to quanta the borders of symmetry have become frayed and fragmented. If symmetry is as purported supersymmetry would be its name.

> Supersymmetry is a theoretical framework in physics that suggests the existence of a symmetry between particles with integer spin (bosons) and particles with half-integer spin (fermions). It proposes that for every known particle, there exists a partner particle with different spin properties. There have been multiple experiments on supersymmetry that have failed to provide evidence that it exists in nature. If evidence is found, supersymmetry could help explain certain phenomena, such as the nature of dark matter and the hierarchy problem in particle physics. 1416

But supersymmetry is broken by exhaustive work trying to find its trace. So, quantum physics has more and more taken a situational perspective to symmetry as a local phenomenon which may have a vastly different kind of mathematics than the culmination of beautiful symmetry in the advent of relativity. Instead of a universal symmetry it may be a local phenomenon. Quantum physics and quantum gravity are unearthing a very different kind of mathematics which can still give an account of conservations of energy and momentum without the universal overtones.

> The new result, which is very far-reaching in its implications, is this: within the framework of AdS/CFT, there are no global symmetries. The paper itself, published on May 17, 2019

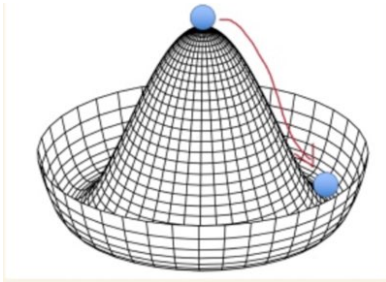
> [above], is titled Constraints on Symmetries from Holography and was written by Daniel Harlow and Hirosi Ooguri. In particular, it showed that—again, within the context of AdS/CFT—that the following three conjectures are true.
>
> Quantum gravity does not allow global symmetries of any type.
>
> Quantum gravity requires that any internal gauge symmetry (which implies conservation laws like electric charge, color charge, or weak isospin) is mathematically compact.
>
> Quantum gravity requires that any internal gauge symmetry necessarily comes along with dynamical objects that transform in all irreducible representations. [1417]

Guage symmetry is a mathematics which removes universal symmetries but still thrives to keep symmetries as local effects. Put simply, gauge symmetries are transformations that leave the physical content of a theory unchanged while altering its mathematical description. Gauge symmetries are necessary in order to explain new degrees of freedom, new information which arises as we look deeper into quanta. One example of a gauge symmetry is how Maxwell's equation of electromagnetism can be explained in terms of local phase transformations of the electromagnetic field. What are these new degrees of freedom in the specific case of local phase transformations of the electromagnetic field? The knowledge of gauge bosons which give rise to photons in electromagnetism. Other gauge theories like Yang-Mills theory which describe strong and weak nuclear forces and how the Standard Model of particle physics rely on the mathematics of gauge symmetries. [1418] So, what happens if symmetry breaks down spontaneously without an observer effect?

Spontaneous symmetry breaking is a concept in physics that occurs when a physical system transitions from a symmetric state to

an asymmetric state without any external influence. Imagine a system governed by physical laws (such as quantum mechanics) that exhibit certain symmetries. These symmetries could be related to translation, rotation, or other transformations. The equations of motion or the system's Lagrangian (a mathematical description of its dynamics) respect these symmetries. Despite the symmetrical equations, the system's lowest-energy vacuum solutions (the stable states it can settle into) do not necessarily exhibit the same symmetry. In other words, the ground state of the system spontaneously breaks the symmetry, even though the underlying physical laws remain symmetrical. In using the phrase 'ground state' I mean its state relative to potential energy.

> Even when a physical system has certain symmetry, the lowest energy state may spontaneously
>
> break that symmetry. This has a lot of implication for the low energy excitations in the system.
>
> The simplest illustration of this idea is the Mexican hat. The shape of the hat (hence the potential
>
> energy) is invariant under the rotation around the vertical axis. If we put a ball at the top of
>
> the hat, that is an unstable equilibrium point and under small perturbation the ball would go
>
> downhill (downhat) into the valley. Each point in the valley has the lowest potential energy so is a
>
> stable equilibrium point. The ball may roll into any of these points but once it does, the rotation
>
> symmetry of the system is broken. Exactly which point the ball rolls into depends on the details
>
> of the initial perturbation. [1419]



1420

The smallest perturbations (disturbances) in quantum physics can cause massive unpredictable changes to spacetime and even our so-called laws of physics.

> Throughout this book I have dismissed beauty, uniqueness, and elegance as false mirages. The Laws of Physics (in the sense that I defined them in chapter 1) are neither unique nor elegant. It seems that the world, or our part of it, is a Rube Goldberg machine. 1421

Susskind even goes further to speculate that the observer effect has possibilities which are truly mind-boggling.

> 4 Bulletin: Just as I was about to finish writing this book, Guth wrote a paper (Alan Guth and David I. Kaiser, "Inflationary Cosmology: Exploring the Universe from the Smallest to the Largest Scales," Science 307 [2005]: 884-90) in which he said, "This idea—that the laws of physics that we observe are determined not by fundamental laws, but instead by the requirement that intelligent life can exist to observe them—is often called the anthropic principle. Although in some contexts this principle might sound patently religious, the combination of inflationary cosmology and the landscape of string theory gives the anthropic

principle a viable framework." Has Alan just opened the closet door? [1422]

Crystals, magnets, and conventional superconductors undergo spontaneous symmetry breaking. For instance, when a liquid freezes into a solid, the system's properties change significantly. Imagine an upward dome with a circular trough at the bottom. If a ball rests at the dome's peak, the system is symmetric. However, if the ball rolls down to the trough (the point of lowest energy), the overall system loses its symmetry while the individual components (dome and ball) retain theirs. Notably, topological phases of matter (like the fractional quantum Hall effect) defy spontaneous symmetry breaking. When spontaneous symmetry breaking occurs, observable properties of the system change. For example, density, compressibility, thermal expansion coefficient, and specific heat may all be affected during phase transitions. As I will discuss later there are theories of spontaneous symmetry breaking in evolution and biology. Spontaneous symmetry breaking is a captivating phenomenon where the system's ground state doesn't respect the symmetry present in its fundamental laws. It is *phusis* adding a touch of unpredictability to our classical ordered universe.

First of all, Chaos came-to-be -> Entangled Wormholes

"First of all, Chaos came-to-be" was Hesiod's famous retort to the Muses' question of, "which of the gods was the first that came to be?" In this section I want to explore a possible scenario which could lend credence to these anarchic beginnings.

In a Scientific American article entitled, "Entangled Wormholes Could Pave the Way for Quantum Gravity", [1423] Juan Maldacena, a theoretical physicist at the Institute for Advanced Study, in Princeton, New Jersey, writes that theoretical quantum physics is full of mind-boggling ideas including entanglement and wormholes. Entanglement shows a surprising correlation between atoms and

subatomic particles with no apparent link at all. And wormholes connect vast distances in space as if the distance did not exist. Even more strange, both of these phenomena may point to a similar connection. Could quantum mechanic's entanglement and relativity's wormholes be the same phenomenon described differently? If so, what could this imply further? To refer back to a previous discussion, could we all still be living in the Big Bang singularity and simply call it *reality*?

Maldacena tells us this odd equivalence could have profound consequences. Could spacetime itself emerge from entanglement? I wonder, might we think of spacetime itself as a "singularity"? My interpretation of what Maldacena muses is that spacetime, wormholes, and entanglement may not be the difference between the very large and the very small but actually the same. He cites string theory which is one approach to quantum gravity. I think what he means by this is that quantum gravity cites geometry as what some have thought may actually be higher density entanglement. So, gravity is not like a typical force that acts locally but what we perceive as vast distances (perhaps infinitely an asymptotic limit?). String theory posits multiple dimensions which get rolled up into what we may perceive as asymptotic limits. Maldacena thinks this might explain wormholes or Einstein, Podolsky, Rosen (EPR) sheets of space folded up on each other. In this way Maldacena seems to hold on to the notion of physicality as wormholes are a physical bridge between two blackholes. And, I might add, it may be that "entangled particles" are what we think of as *small* wormholes. Ok, Maldacena may have preserved the notion of *physicality* but at the cost of complexity? It seems to me this notion of complexity could only truly be thought of as quantum chaos. But what do I know?

As we already mentioned, only a genius like Einstein could have published two papers in 1935 describing something he could not understand or reconcile with physics or philosophy. However, as the decades rolled on those papers proved themselves to be more

and more ingenious. In a Schwarzchild singularity or what we now call a blackhole there is an outside and an inside. On the outside some matter can escape at a certain distance by curving around the blackhole in the same way matter can escape the gravitational pull of any massive object like a sun for example. On the other hand, absolutely everything and anything which enters the blackhole never returns once it enters the event horizon. A wormhole between two blackholes will pull apart so fast that anything falling into either end of the wormhole will never meet. The wormhole pulls apart so fast that nothing can ever reach the middle where the two singularities meet. There is no quantum teleportation of any 'thing' as matter between blackholes through a wormhole…except exformation. We already know that entanglement has no functional dependence on spacetime or cause and effect. This means entanglement does not recognize blackholes as an obstacle either. Additionally, as already discussed, the Big Bang looks a lot like a white hole. Therefore, in the discussion that follows I want to move towards thinking about how a blackhole/white hole and a Big Bang could be synonymous. Blackholes and white holes may be the same phenomenon as already discussed earlier. [1424] However, the previous discussion focused on a blackhole over its lifetime turning into a white hole and dissipating eventually to preserve information. What if a blackhole and a white hole are simultaneously the same phenomenon except in a complementarity fashion? Additionally, what if everything we call anything 'fell' up from exformation as emergent spacetime.

Could it be that we and the universe emerge from exformation? Another way of thinking about this is exformation escaping from a white hole could otherwise be called the Big Bang. One possible avenue of how this might work out could be worldsheets emergent from loop quantum gravity worldlines. In this section I want to explore a more speculative approach to cosmology which brings Hesiod's *phusis* into ideas of current physics.

Exformation can be thought of as producing, causing, emerging,

spacetime instead of spacetime just somehow Being there 'absolutely' or 'eternally' and then mysteriously falling forever from a non-ontological, 'metaphysical' singularity. Wouldn't it be simpler, less contrived in terms of cosmological origin, although spookier, to think chaotic information in a white hole singularity, not already assembled as cause and effect, as emerging from its event horizon in three-dimensional space with temporality emerging as superposition/branching worldsheets? Could it be that worldsheets are evolving futures with narrated, crystalizing pasts arising from loop quantum gravity worldlines? Could it be that worldlines result from superposition and its 'collapse' or better temporally branching worlds?

Let's go back to complementarity. While nothing can survive the singularity of a wormhole, entanglement has exactly that –> no-thing between entangled particles or entangled systems. There is no 'in-between' of entangled particles and systems. There is no spacetime, cause and effect, etc., there is only exformation. In our white hole/Big Bang scenario we have a singularity. A singularity has no size. It is infinitesimally small, infinitely small, or has no existence in spacetime. This means it has no space and no time. There is no ontic, existent time zero, only an ontic, existent after time zero because spacetime does not exist in exformation. In terms of the Big Bang, we can conceptually think of the singularity immediately after the non-existent time zero as an expanding two-dimensional event horizon. This is the cosmological horizon shaped by the speed of light as the expanding Cosmic Microwave Background (CMB). One perspective of the complementarity, two-dimensional event horizon surface of the Big Bang, CMB, observable universe, is the event horizon. The event horizon is encoded with the quantum wave function as exformation spookily retaining whatever went into the event horizon and the singularity.

By using the term 'encoded information' we are not referring to some deterministic code which can be thought of in classical terms as a predetermined code that simply needs a decoder to order an

absolute universe from beginning to end. Instead, this encoder necessarily relies on a spooky relationship with the observer effect, superposition, and branching information we have already found in the quantum wave function. One possible idea of how the exformation of the event horizon of the Big Bang and a singularity might work is the evolving block universe or a crystallizing block universe. Also, remember how the crystallizing block universe has a spooky way of incorporating neurological, sociological, and historical narratives as worldsheets arising from worldlines that do not fit conveniently into our simplified historical categories of subjective or objective.

Following this notion, Hawking radiation emitted from the blackhole event horizon is encoded information of what went into the event horizon. This information could be thought of as a kind of spooky informational mirror of what went into the singularity of a blackhole. All this exformation is reflected both into, at the event horizon, and out of, Hawking radiation, the blackhole. So, exformation is a kind of Aristotelian potentiality, as spookily encoded information with no ontic, existent content. However, it gets actualized as emitted Hawking radiation on the outside of the Blackhole. But what if the potential singularity on the inside as a wormhole gets actualized again through another white hole? In this case, the other white hole could be thought of as a cosmological, emergent Big Bang into another universe. The emergence of exformation from the other white hole, the Big Bang, would then be one possible origin or cosmology. Since spooky information, the observer effect of the quantum wave function, is mirrored on both sides of the wormhole, innumerable many branches would also be retained on both sides of the wormhole.

More specifically, our cosmology which I discussed earlier in the ‘Cosmology’ section emerges as the Big Bang. Our *phusis* emerges as spacetime from exformation mathematically consistent with the two-dimensional, cosmological event horizon surface which gets decoded as emergent, three-dimensional space. Perhaps, time would

then emerge as the quantum wave function, observationally, perhaps branching, evolving futures coupled with the worldlines of a spooky narrative as branching pasts that cannot be thought of as purely subjective or objective. It is interesting to note that just as worldlines arise from zero-point energy, vacuum energy, this pattern of two-dimensional/three-dimensional complementarity was repeated no matter how you sliced up spacetime.

The nexus of both future and past, abstract and concrete, is the spooky externalities of physics' exformation and *phusis'* stretch of lived time and lived space. The crossing is living presents which branches as informational updates. The nexus and the crossing never meet in *phusis*. They remain on the hither side of the abyss of exformation. They are not related by deterministic, cause and effect. They are not mediated in ontology and the history of Being. They are not resolved by non-contradiction, a higher order which establishes them in contradistinction to each other.

Let's say that the wormholes meet in the middle where no matter can ever exist, even 'exist' cannot exist. Can we imagine that, from the outside, the blackhole has converted everything that falls into the blackhole to spooky exformation which has lost any sense of spacetime, cause and effect, or geometry as a singularity? However, exformation still exists exhibiting itself as Hawking radiation, three-dimensional geometry as we observe from the outside of the Blackhole's event horizon. Here, looking from the outside of each blackhole, we also observe encoded information on the two-dimensional, event horizon surface area. The event horizon spookily encodes three-dimensional volume as space. The wormhole has converted all spacetime into exformation. Since exformation has no sense of spacetime, the wormhole singularity does not have any super deterministic cause-and-effect influence on entangled particles at the surface of the event horizon or emitted back out as Hawking radiation.

Recall the complementarity of the blackhole and the white hole which is very different depending on your perspective. Yet both

black holes and white holes emit exformation and consume exformation simultaneously. On the outside of the blackhole, we see 2-D event horizon and 3-D Hawking radiation. On the outside of the white hole, we see the 2-D expanding cosmological event horizon and 3-D emergent space with the spooky temporality of worldsheets. Certainly, this is much like Alice down/up the rabbit hole. One important thing to bring up at this point is that one way dark matter and dark energy are thought to occur is through Hawking radiation.

> If even a relatively small number of black holes were created in the early universe, they will constitute an increasingly large fraction of the total energy density as space expands. It is thus well-motivated to consider scenarios in which the early universe included an era in which primordial black holes dominated the total energy density. **Within this context, we consider Hawking radiation as a mechanism to produce both dark radiation and dark matter.** If the early universe included a black hole dominated era, we find that Hawking radiation will produce dark radiation at a level $\Delta N_{\rm eff} \sim 0.03 - 0.2$ for each light and decoupled species of spin 0, 1/2, or 1. This range is well suited to relax the tension between late and early-time Hubble determinations, and is within the reach of upcoming CMB experiments. The dark matter could also originate as Hawking radiation in a black hole dominated early universe, although such dark matter candidates must be very heavy ($m_{\rm DM} \gtrsim 10^{11}$ GeV) if they are to avoid exceeding the measured abundance.[1425]

To review,
white hole complementarity is:

- chaotic potentiality inside the non-existent singularity of the white hole

- spooky actuality outside the white hole
    - 3-D space and spooky temporality as Emergent//Big Bang/universe
    - 2-D spookily encoded, exformation on the Cosmological expanding event horizon reflecting time after zero, first existence

blackhole complementarity is:

- chaotic potentiality inside the non-existent singularity of the blackhole
- spooky actuality outside the blackhole
    - 3-D space and spooky temporality in Hawking radiation
    - 2-D spookily encoded, exformation on the event horizon shaped by the point where existence becomes non-existent (remember the ocean analogy)

Do we see symmetry here?

As mentioned above Hawking radiation may be the source of that matter and perhaps even dark matter and dark energy.

Cutting to the chase,

> From its discovery as a shadowy force on Uranus, Neptune proved to be a fascinating world in its own right. Might the same be true of dark matter and dark energy? Scientists are increasingly considering the possibility that dark matter, in particular, is not just a contrivance to account for the motion of visible matter but a hidden side of the universe with a rich inner life. It may consist of a veritable zoo of particles interacting through novel forces of nature—an entire universe interwoven silently with our own.[1426]

What if blackholes and white holes are the same phenomenon?

We have already discussed the branching of the wave function as many-worlds or universes within universes. What if the wave function is symmetrically and beautifully reflected as both blackhole and white hole?

We can think of this as complementarity, or as blackhole/white hole layered on top each other, or simultaneously destroying and creating worlds or both spookily occurring simultaneously with no regard for our parochial notions of space and time.

Outside and inside, white hole and blackhole then would be analogously like wave/particle duality depending on your perspective all rolled up with the observer effect.

Our Big Bang would then be the emergence as our universe, the cosmology of our Big Bang. Another universe would be seen by us as dark matter and dark energy we now call Hawking radiation. Since the wormhole singularity connects two blackholes/white holes, exformation between the two can be intermingled but only chaotically relative to spacetime. Here we need to take a 180 degree turn and look at complementarity from the diametrically opposed other side. This is extremely non-intuitive. Instead of thinking that everything that fell into or came out of the wormhole got crunched down to exformation, a wormhole singularity and emerges as a Big Bang universe or Hawking radiation (dark matter/ dark energy trace of another universe), what if it is the opposite?[1427]

From one perspective, we can think of a wormhole 'emerging' spacetime as Big Bang's event horizon decoded *vis-à-vis* our cosmology. From another perspective, we can think of Hawking radiation escaping back into the universe. Both have an encoded two-dimensional event horizon surface and spooky three-dimensional spacetime. Through the event horizon and singularity of a wormhole information is spookily encoded and decoded back as universes, matter, as us, as both blackhole and white hole. It may be that a white hole is none other than a blackhole simply

depending on how you look at it, from where you look at it – this is plainly and simply complementarity. Did the universes come first which collapsed down into the blackhole/white hole or did spooky exformation which had no 'first', no predetermination, no existence, no ontology…only chaos, abyss, and the excess to externality.

Instead of thinking,

universe 1 event horizon -> wormhole -> universe 2 event horizon

think,

wormhole <-> event horizons 1 & 2.

By exformation falling out as Hawking radiation or 'universe' falling, spooky observer temporality with its infinite branching wave functions of evolving futures and crystalizing (narrated) pasts or worldsheets, what if both ends of the wormhole emerge from the exformation of the wormhole singularity apart from the falling in/out black hole/white hole…from chaos…quantum wave functionality? In other words, we are not the origin but anarchical (without origin) chaos, an excess to birth and death as the '*is*', emerging us? The point is that we emerge from spooky chaos, exformation, rather than just absolute Being here in eternal spacetime and mystically getting converted to spooky, exformation.

I will not delve into Susskind's three blackholes with one highly entangled wormhole scenario except to suggest that in this scenario emergent universes never exist in pairs but only observationally, informationally from one blackhole to the union of the other two. I write this to again emphasize the observational role of the wave function, its span, its infinite branching, its spooky contingency on observation. We cannot ever eject ourselves from 'being there' as wave function superposition, a reset which rest as oblivion but falls into existence yet once again, branching informational updating, consciousness, birth and death as branches which never converge, excess facing us calls us to responsibility instead of retreat.

To top that off, if that is possible, a number of physicists are conducting experiments which ask the question, what if qubits

which are entangled particles used in quantum computing actually use extremely tiny wormholes to share exformation?[1428] This would mean every entanglement would be accomplished from wormholes. In 2022 a team at the California Institute of Technology conducted an experiment to determine if qubits use a "wormhole teleportation protocol".

> The team, led by Maria Spiropulu of the California Institute of Technology, implemented the novel "wormhole teleportation protocol" using Google's quantum computer, a device called Sycamore housed at Google Quantum AI in Santa Barbara, California. With this first-of-its-kind "quantum gravity experiment on a chip," as Spiropulu described it, she and her team beat a competing group of physicists who aim to do wormhole teleportation with IBM and Quantinuum's quantum computers.
>
> When Spiropulu saw the key signature indicating that qubits were passing through the wormhole, she said, "I was shaken."[1429]

This experiment has its detractors and defenders as is true of many experiments in experimental physics. To be clear tiny wormholes are mathematical wormholes (ER = EPR conjecture, widely respected) not physical wormholes (e.g., sci-fi travel, highly speculative). However, if tiny wormholes in qubits can be discovered, one way to investigate this would be to get enough entangled qubits to generate a tiny gravitational field. We know from Einstein's general theory of relativity that what we call wormholes are mathematically possible. Wormholes would generate a tiny but specific kind of gravity signature which might be possible to detect given enough qubits. If so, a quantum computer would be a gravity producer. If entanglement itself uses Planck sized wormholes to accomplish its information tasks prior to spacetime a wormhole singularity would do this task prior to ontology, to Being,

to existence because a black hole singularity is highly entangled.

If all entanglement is accomplished using wormhole singularities, how does this reflect on our idea of size, time, complexity, universes, and branching information? Is size, time, and complexity more relatively spooky than even Einstein suggested? Could there be universes within universes, branching as worlds within worlds, thrown back as 'me' branching, as subject branching in the face of spooky externality? Here I use the word 'subject' not in the typical way of binary oppositions of subject and object but as a spooky kind of subjectivity. Could it be that the distance between 'I' and the Other (*Autrui*) never meet as particle, as spacetime, as a distance infinitely retreating into the singularity between us? Could it be that this spooky, chaotic, exformation, "*passivity more passive than all passivity*", faces us in radical alterity from which me as subject, as 'I', retreats from, to echo, the narcissism of Being, histories conceived of as substance, *substantia* while perpetually branching as information updates from superpositions. In retreat, the historic narrative of 'me' escapes the call of responsibility to radical alterity, the he or she which can never be of my origin? More on that later.

All of this is highly speculative, abstract, and hard to make sense of, so later I will discuss something much more concrete built on the same spooky physics - quantum computing. After the next section, I want to take a look at the classical and modernistic historic origins of the machine. The machine has become a dominant metaphor for how we *a priori* have historically been conditioned to metaphysically understand reality. What instinctively draws us away from spooky *phusis* to the comfort of mechanics used in the term 'quantum mechanics'?

First, throughout this book I have discussed spacetime as emergent from chaotic exformation. Because of this, it might be easy to think of chaotic exformation as 'causing' spacetime. In that case entanglement might be thought of as the origin of spacetime. I think I have even referred to entanglement as 'causing' spacetime

myself for brevity. However, emergence is a much better way to think of this relationship. I will discuss the finer points of emergence later but from now emergence is not a 'cause' in a technical sense. For now, emergence is an unbridgeable leap from one state to another without any traceable predecessors which could rightly be thought of as causal. Nevertheless, in the next section I want to discuss historic reasons why using the notion of causation to understand entangled emergence might seem to offer some familiar byways to comprehension while actually clouding the issue more than it clarifies.

The Rule of Origin Over Chaos

There is one other point I want to make here. If we want to think of chaos as origin, we immediately run into a logical contradiction and historical problem from our Greek and Latin inheritance of the idea of origin.

Aristotle tells us that logic in the principle of non-contradiction rules in origin. In Book 4, Part 3 of Aristotle's Metaphysics, he tells us,

> The Most Fundamental Principle of Knowledge: The Law of Non-Contradiction
>
> Which principle this is, let us proceed to say. It is this: the same attribute cannot at the same time belong and not belong to the same subject and in the same respect--we must presuppose, to guard against dialectical objections, any further qualifications which might be added.
>
> This, then, is the most certain of all principles, since it answers to the definition given above. For it is impossible for any one to believe the same thing to be and not to be, as some think Heraclitus says. For what a man says, he does not necessarily believe; and if (1) it is impossible that contrary attributes should belong at the same time to the same subject

> (the usual qualifications must be presupposed in this premise too), and if (2) an opinion which contradicts another is contrary to it, then obviously (3) it is impossible for the same man at the same time to believe the same thing to be and not to be; for if a man were mistaken on this point he would have contrary opinions at the same time....[1430]

Aristotle opposes the earlier spookiness of Hesiod and Heraclitus by dismissing the *logos* of origin from chaos. This prepares the way for Leibniz' Principle of Sufficient Reason and Hegel's immanence of Concept. This sets the stage for logical negations which changed earlier notion of *logos* to logic and *phusis* to classic physics. Negations such as presence and absence left no excess and reduced *phusis* to binary oppositions. This is the advent, the epoch, of rule over chaos. Aristotle tells us, "*it is impossible that contrary attributes should belong at the same time to the same subject*" but now quantum physics tells us precisely this in complementarity and spooky *phusis* which is not subjective or objective but something which cannot find any *belong*ing, rule or authority to any such *thing* as "same time" or "same subject". Logic fails us at the abyss.

The Greek word *arche* is translated as origin but has wider meanings in ancient Greek usage as 'beginning', 'sovereignty', 'dominion', and 'authority'.[1431] As I mentioned earlier the word 'origin' comes from the Latin word *originem* meaning a rise, commencement, beginning, source; descent, lineage, birth - from stem of *oriri* "arise, rise, get up; appear above the horizon, become visible; be born, be descended, receive life;" figuratively "come forth, take origin, proceed, start.[1432] From the most ancient times the idea of rule, sovereignty, dominion, authority, lineage, birth, and 'take origin' set up a hierarchy of rule and control. The beginning in this sense could not have been chaos. Origin has always been used as an endowment of privilege. It was a royal signet which granted authority. However, as I have shown, there was also a counter narrative to this in its earliest usages as Hesiod's

answer to the Muses which placed chaos, the yawning gap, as the first, the arche. In this sense the *arche* defied origin and rule. Perhaps this history is best thought in terms of *an-archy,* no origin. Anaximander was part of the tradition of *an-archy* with *aperion* (without form, void, chaos) as the unlimited. Heraclitus tells us in different fragments,

> Heraclitus, I believe, says that all things pass and nothing stays, and comparing existing things to the flow of a river, he says you could not step twice into the same river. (Plato Cratylus 402a = A6) [1433]
>
> B12. potamoisi toisin autoisin embainousin hetera kai hetera hudata epirrei.
>
> On those stepping into rivers staying the same other and other waters flow. [1434](Cleanthes from Arius Didymus from Eusebius)
>
> B49a. potamois tois autois …
>
> Into the same rivers we step and do not step, we are and are not. [1435](Heraclitus Homericus)
>
> B91[a]. potamôi … tôi autôi …
>
> It is not possible to step twice into the same river according to Heraclitus, or to come into contact twice with a mortal being in the same state. (Plutarch)[1436]

There is no 'same' in Heraclitus. There is no origin to which we belong. No *mortal being* is ever in the *same state*. Domination and rule can only happen as Being, thought under the rubric of a logic which reduces all to the *same*.

Constantine the Great brought Christianity to the Roman empire in 312 AD. While he continued to devote himself to the pagan sun god Sol, he found ways to integrate Jesus as the personification of Sol. This was an early beginning, an origin, as a sign and signet of rule and authority for an absolute God. At this point in the Roman empire, the emperor as a god was wearing thin. Constantine

ingeniously resolved his rule and authority, by continuing to conquer the ancient world under the banner of monotheism.

> It is said that the emperor either had a dream or vision on the night before his famous battle against rival Maxentius in 312. There was also a script in the background that read “In Hoc Signo”, which means “In this sign, conquer”. After his victory over Maxentius, the emperor and his court officials, many of whom were leaning to Christianity, would interpret the vision as sign from the Christian God.
>
> The emperor made this revelation known to Eusebius of Caesarea (260-339), a Christian historian and theologian best known for works such as “Ecclesiastical History” and “The Life of Constantine”. Eusebius’ works had a significant influence on the development of Christian thought and theology.
>
> Some historians maintain that Eusebius managed to convince the emperor that the vision came from the Christian God and not Sol Invictus. Further interpretation of the vision was made by Eusebius to reinforce the first assessment.
>
> Regardless, Constantine continued to maintain his devotion to Sol, offering sacrifices to the Roman god. There was considerable effort from the Emperor to merge the two beliefs – Sol and the Christian God.[1437]

In the same year, 312 AD, that Constantine made Christianity the state religion of Rome he defeated Maxentius at the Battle of the Milvian Bridge. Later the Roman senate erected the Arch of Constatine.

> The Arch of Constantine (Italian: Arco di Costantino) is a triumphal arch in Rome dedicated to the emperor Constantine the Great. The arch was commissioned by the Roman Senate to commemorate Constantine's victory over

> Maxentius at the Battle of Milvian Bridge in AD 312. Situated between the Colosseum and the Palatine Hill, the arch spans the Via Triumphalis, the route taken by victorious military leaders when they entered the city in a triumphal procession.[1438]

The Greek root *arch* means rule. It is drawn from the Greek word *arche* meaning origin. The appeal of the ancient world's military and philosophical conquest of chaos congeals as what Derrida refers to as logocentrism, narratives, epic tales or *epos* (word, song, epic)[1439] throughout Western history, Epochs or ages from ancient civilizations prior to Constantine, after Constantine, the Renaissance, through modernity[1440] all of what Heidegger calls the epoch of Being, echoing through the annals of war and the détente of peace desiring the absolute privilege of rule, of origin. In the Christian religion of Galileo, Kepler, Descartes, Copernicus, and Newton, *phusis* consolidates as the physics of absolute time and space subsumed from earlier metaphysics of God, THE origin, signifying authority and rule and sealing the Western triumph over chaos.

> It was Newton's great achievement to invent the notion of an absolute and continuous time. Such a concept was needed for the formulation of his laws of mechanics and universal gravitation. Although Newton's concepts of absolute space and absolute time were heavily criticized by some contemporaries as being unobservable, alternative relational formulations were only constructed after the advent of general relativity in the 20th century.[1441]
>
> Isaac Newton formulated his ideas on space and the universe during his early years at Cambridge in response to René Descartes's 1644 publication Principles of Philosophy. Sometime between 1666 and 1668, in an unpublished manuscript that we refer to by its opening words, De

> gravitatione, Newton wrote that an "infinite and eternal" divine power coexists with space, which "extends infinitely in all directions" and "is eternal in duration." Descartes claimed that where there is no matter there can be no space; on the contrary, argued Newton, space, by virtue of omnipresent spirit, exists where there is no matter. Descartes claimed that matter extends indefinitely; on the contrary, argued Newton, God has created in infinite space a material system of finite extent.[1442]

Quantum physics is an extreme departure from this history, origin as rule. Quantum physics harkens back to ancient intuitions of chaos but without the signet of rule, war, dominion, and domination. It is an extreme departure from certainty given by force. It overturns much of our history of Being, reality, existence. This *is* shown in its inability to *be* able to find easy words, thoughts, and concepts. I understand all this contemporaneous impact as the end of all epochs, of all dreams. On this precipice there is retreat into reactionism, to lull oneself to sleep in the *epos* of long-held tales where heroic phantasms of origin echo endlessly throughout the dark night of the soul. Ever branching narratives of substance never arrive to a 'me' as absolute only endlessly deferring the promise of ultimate self-rule, the phoenix rising from its own ashes to glory in salvation, resurrection, and death. To wake would be to face radical alterities which call for responsibility before the sleep of self-origin which passively desires to rationalize myself into comfortable historic logics (logocentrisms) of the 'way it was' in dreamland. In sleep we must perpetually rise to the gaze of Orpheus turning back to see our love's desire, Eurydice tragically fading one step away into the dissolution of nightmare which can never cease reasserting rule and dominion over the uncertainty of *phusis*.

Emergence and Novelty

There are two schools of thought on emergence: classical emergence and quantum emergence.

Classical emergence refers to the phenomenon where a complex system exhibits properties or behaviors that cannot be directly attributed to any individual component within that system. These emergent properties arise from interactions among the system's parts, rather than being inherent in any single part. For instance, consider life as studied in biology. Life emerges from the intricate interactions of chemical processes (governed by chemistry) and quantum phenomena (governed by quantum physics). Life is more than just the sum of its molecular components; it's an emergent property of the whole system. Philosophers have termed this emergence as a "categorial novum"—a new category that emerges when components interact in novel ways.

Quantum emergence exhibits emergent behavior due to inherent complexity. Quantum coherence (superposition and entanglement) at the microscopic level can lead to macroscopic effects. For instance, superconductivity emerges at very low temperatures when countless electrons cooperate coherently with zero electrical resistance. This behavior cannot be understood solely by understanding the behavior of individual electrons. Quantum phase transitions occur near absolute zero temperature when subtle changes in a system's parameters lead to dramatic shifts in its behavior. Emergent phases (like magnetism or superfluidity) arise. The quantum Hall effect in 2D electron systems subjected to strong magnetic fields, quantized Hall conductance emerges due to topological properties of the wave functions. Entanglement between particles can lead to emergent phenomena like quantum teleportation or quantum cryptography. The study of fluid dynamics, or hydrodynamics, also involves emergent behavior. The collective motion of countless water molecules gives rise to phenomena like waves, turbulence, and vortices. In the cosmic realm, pulsars—rotating neutron stars—exhibit a form of superfluidity. The neutrons within pulsars behave collectively as a

superfluid, and this behavior emerges from the interactions of these particles. Emergence is also observed in quantum plasmas, where the behavior of charged particles (ions and electrons) collectively leads to novel effects.

Despite progress, understanding quantum emergence remains challenging. For example, how does a quantum wave function collapse upon measurement? Emergence of classical reality from quantum superposition is still not fully resolved. Combining quantum mechanics with general relativity (quantum gravity) is an ongoing quest. Emergent spacetime itself poses deep questions. Some theories suggest consciousness emerges from complex quantum processes in the brain. However, this remains speculative. Emergence challenges reductionism—the idea that everything can be explained by breaking it down into smaller parts. It highlights the richness of nature, where novel properties emerge from interactions. Philosophers debate whether emergence implies a fundamental irreducibility or if it's merely a result of our incomplete knowledge. Emergence from the quantum wave function showcases the intricate interplay between fundamental physics, complexity, and the emergence of novel phenomena. It's a frontier where science, philosophy, and mystery converge.

Novelty refers to the appearance of something new or unexpected within a system. In the context of quantum physics, novelty often arises due to the quantum nature of particles and their interactions. For example, consider photons—the fundamental particles of light. Their behavior, described by quantum theory, exhibits novel features such as wave-particle duality, entanglement, and superposition. The central novelty of quantum theory lies in its description of the state of these particles, which defies classical intuition.

Emergence and novelty in quantum physics remind us that the whole can be greater than the sum of its parts. When Solomon stated that there is nothing new under the sun, he must not have known about quantum physics. Certainly, quantum physics has

repeatedly shown us that many shadows of what we see on the macroscopic scale find some kind of spooky relevance on the microscopic scale. But even more than that, when quantum complexity reaches critical limits, emergent behavior cannot be predicted from individual components. This is when the physics of emergence shows highly different organizational motifs in areas such as superconductors/superfluidity, hydrodynamics, Bose Einstein condensate, string-net conversion and even more in the very structure of the universe.

During the early moments after the Big Bang, the universe underwent a phase called inflation. This process made the universe extremely homogeneous. However, quantum fluctuations introduced density variations from place to place. These fluctuations acted as seeds for the large-scale structure we observe today. Think of the universe as a cosmic foam, with voids, galaxy clusters, sheets, and filaments. The intricate cosmic web of galaxies and cosmic structures emerged from these initial quantum fluctuations. While not directly quantum physics, the nature of spacetime itself serves as an example of emergence. Some theories propose that spacetime might emerge from a more fundamental reality. Understanding this emergence could unlock the quest for a quantum theory of gravity. Figuring out the true nature of spacetime remains one of the most urgent goals in modern physics. Emergence and novelty in quantum physics reveal hidden layers of complexity within the fabric of our universe.

If ‘reality’ were absolutely static and deterministic Solomon would have been correct. In stating that spacetime is emergent from a spooky sense of superposition (and entanglement as we will see) we are not suggesting the easy historical avenue of atemporal and aspatial absolutes which simply ‘are’ in eternity. That would be too easy and therefore should draw suspicion. In quantum physics the unhinged, spooky quality is not a case of going to the ‘shopping center’ of history and finding the correct idea to tame the idea into submission. Quantum physics asks us to incline our ear along a path

which is not easy.

Quantum phenomena continually challenges our understanding. Even more than that, our understanding will never provide a classical answer to uncertainty, probability, and the observer effect. In 1927, Heisenberg laid out the reasons why knowledge will never be able to resolve uncertainty. In classical physics position and momentum were all you need to understand any mechanical behavior. In quantum mechanics, we can never know the position and momentum of a particle simultaneously. The more accurately we measure position, the less accurate momentum will be and vice versa. Mathematically, the uncertainty principle relates the uncertainty in the position of a particle (Δx) and the uncertainty of the momentum of a particle Δp) as:

$$\Delta x \cdot \Delta p \geq \hbar/2$$

where ħ (h-bar) represents the reduced Planck constant. When Planck scales become important, this relationship tells us that the more we know about the position of a particle the less we know about the momentum of a particle and vice versa.

Bohr introduced the reduced Planck constant which is the Planck constant divided by 2π. This takes frequency out of the equation and makes commonly used angular momentum easier to work with in terms of radian units. The reduced Planck constant, denoted as $\hbar$ (h-bar), is a fundamental physical constant in quantum mechanics. It relates to the Planck constant h in the same way that hertz relates to radians per second. Specifically, one hertz corresponds to one complete cycle, which is equivalent to 2π radians per second. This value is used when working with angular frequency in radians per second, rather than plain frequency in hertz. It allows us to work with angular quantities more naturally, especially when dealing with wavefunctions, angular momentum, and other rotational aspects of quantum systems. Mathematically, the relationship between the reduced Planck constant and the

Planck constant is given by:

$$\hbar = h / 2\pi$$

Where: $\hbar$ (h-bar) represents the reduced Planck constant and h represents the Planck constant.

The reduced Planck constant equals $1.054571817 \times 10^{-34}$ (Joule)-seconds).

In classic mechanics uncertainty in position and momentum is not due to *phusis* but from our own inaccuracies of initial conditions. Edward Lorentz (1917-2008) likened this problem in classic physics to the butterfly effect.

> In [classical] chaos theory, the butterfly effect is the sensitive dependence on initial conditions in which a small change in one state of a deterministic nonlinear system can result in large differences in a later state. The term is closely associated with the work of mathematician and meteorologist Edward Norton Lorenz. He noted that the butterfly effect is derived from the metaphorical example of the details of a tornado (the exact time of formation, the exact path taken) being influenced by minor perturbations such as a distant butterfly flapping its wings several weeks earlier. Lorenz originally used a seagull causing a storm but was persuaded to make it more poetic with the use of a butterfly and tornado by 1972. He discovered the effect when he observed runs of his weather model with initial condition data that were rounded in a seemingly inconsequential manner. He noted that the weather model would fail to reproduce the results of runs with the unrounded initial condition data. A very small change in initial conditions had created a significantly different outcome.
>
> The idea that small causes may have large effects in

> weather was earlier acknowledged by French mathematician and engineer Henri Poincaré. American mathematician and philosopher Norbert Wiener also contributed to this theory. Lorenz's work placed the concept of instability of the Earth's atmosphere onto a quantitative base and linked the concept of instability to the properties of large classes of dynamic systems which are undergoing nonlinear dynamics and deterministic chaos.
>
> The butterfly effect concept has since been used outside the context of weather science as a broad term for any situation where a small change is supposed to be the cause of larger consequences. 1443

Contrarily, due to quantum chaos and complexity, if we see the butterfly flapping its wings, we will be incapable of finding our way to the tornado weeks later. Additionally, in any sense of practicality, we will never be able to reverse the direction (called the antiunitary operator in the quantum wave function) from the tornado to the butterfly flapping its wings. No amount of finely tuned initial variables will ever get us there. In order to do this, some have speculated that we would have to have absolute, complete knowledge of the universe, of everything, as a single, complete wave function (without ever collapsing into classical states). This would be called LaPlace's demon or religion's idea of God. Initially, the uncertainty principle was linked to the observer effect, which suggests that measuring a system disturbs it. However, we now understand that the uncertainty principle arises from the wave-like nature of quantum phenomenon. It's not about our measurement process; it's a fundamental property of quantum systems. Heisenberg's revelation challenged classical determinism. It showed that deterministic cause-and-effect physics fails when applied to atoms. Quantum mechanics, with its inherent uncertainty, opened up a new understanding of reality. The uncertainty principle isn't just a technological limitation; it's woven

into the fabric of quantum reality. While we can improve our measurement techniques, we'll always encounter this inherent uncertainty in the quantum world. Planck's constant sets the limit where the quantum world melds into our day-to-day world. Novelty and emergence arise from quantum chaos and spill into areas such as biological processes and evolution. Let's take a closer look at what is meant by classical chaos theory and quantum chaos theory. The practical, observational inability of the wave function to incapsulate all multiverse information defies spacetime and will tell us something important about chaos. From a physics perspective there are two kinds of chaos theory: classical chaos theory and quantum chaos theory.

Classical Chaos Theory

Classical chaos theory is a branch of mathematics that delves into the behavior of complex systems. These systems exhibit a remarkable sensitivity to tiny changes in their initial conditions. In the classical world uncertainty and probability were not due to 'reality'. Instead, uncertainty and probability had to do with not having enough information. In the classical world, it was understood that reality was infinite and infinitesimal. Therefore, if something appeared uncertain and probable it was because our starting assumptions were not encompassing enough. For example, deviations in the motions of planets did not have enough granularity to adequately explain their motion. Calculus which started with Newton and Leibniz was all about changes and changes of changes and changes of changes of changes, etc. For example, the change of speed is acceleration. The change of acceleration is momentum and so on. If the fine tunings of these changes were not adequately understood the problem was not in reality but in the inadequacy of our calculations.

Chaos theory deals with systems that are deterministic, meaning their future behavior follows a unique evolution determined by

their initial conditions. However, despite this determinism, they can behave in an unpredictable and chaotic manner. Within seemingly random and disorderly systems, chaos theory reveals underlying patterns. These patterns include interconnections, feedback loops, repetition, self-similarity, and even fractals. So, chaos is not mere randomness. Neither is it disorder. It does not deny disorder or order but encompasses it and exceeds it. One of the most captivating concepts in chaos theory is the "butterfly effect". It states that a small change in the initial state of a nonlinear system can lead to vastly different outcomes in the future. Imagine a butterfly flapping its wings in Texas causing a tornado in Brazil—such is the sensitivity to initial conditions. Chaos exists in various natural systems, including fluid flow, heartbeat irregularities, weather, and climate. Even artificial systems like road traffic can exhibit chaotic behavior (we should probably add politics to this list). Chaos theory finds applications in diverse fields such as meteorology, anthropology, sociology, environmental science, computer science, engineering, economics, ecology, and pandemic crisis management.

Classical chaos theory teaches us to expect the unexpected, revealing hidden order within apparent randomness. The assumption of order supersedes in apparent disorder. Chaos is equivocated to disorder. Any externality must always be taken up again into a principle, a higher Concept which unites to seemingly opposing concepts. It is an idealized assumption of unity which underlies semblance, the illusion of chaos as disorder. Starting in the 20th century the classical illusion of underlying reality was finally overturned by the advent of quantum chaos theory (and in Philosophy by the advent of Emmanuel Levinas).

Quantum chaos bridges the gap between quantum mechanics and classical mechanics. It seeks to explore how chaotic behavior in classical dynamical systems can be described using quantum theory. Classical mechanics emerges as the classical limit of quantum mechanics when the ratio of Planck's constant to the action of the

system approaches zero. This means that the limit, the end of classical physics is the line where Planck's constant shows that energy is quantized instead of continuous. Planck's constant is 6.626×10^{-34} J(oule)·H(ert)z^{-1} in SI units. Planck's constant relates the energy of a photon to its frequency. To give you an idea of how small this is, Planck length is 10^{-35} meters and Planck time is 10^{-43} seconds. When the classical world starts looking discrete rather than continuous, we enter into the world of quantum physics, what underlies and gives rise to classical physics. This correspondence principle suggests that there must be quantum chaos theory underlying classical chaos theory, even though directly examining classical chaos through quantum mechanics may not always be fruitful. The word perturbation means a deviation of a system, moving object, or process from its regular or normal state or path, caused by an outside influence. Interestingly enough it is also used to mean anxiety or mental uneasiness. Quantum physics has some rules to explain quantum perturbations in less complex, tightly controlled situations. However, quantum chaos involves developing methods to solve quantum complexity problems where perturbation theory doesn't apply (i.e., the perturbation cannot be considered small) and quantum numbers are large. Sometimes researchers can correlate statistical descriptions of energy levels (eigenvalues) with the classical behavior of the same system. As the classical world of science matured, statistics became more essential than absolute principles. We see this in 19th century empirical positivism where statistics played a major role instead of universal principles. The probability distribution of individual eigenstates is studied, including phenomena like 'scars' and quantum ergodicity.

Quantum scars refer to a remarkable phenomenon observed in the eigenstates of classically chaotic quantum systems. These eigenstates exhibit enhanced probability density around the paths of unstable classical periodic orbits. Quantum scars seem to arise due to quantum interference. This kind of behavior is not understood in terms of more traditional treatments of quantum

behavior. A classically chaotic system is also ergodic, meaning its trajectories eventually explore the entire accessible phase space evenly. However, scars provide a significant correction to this assumption. Techniques like periodic-orbit theory connect classical trajectories with quantum features. Investigating how quantum mechanics underpins classical chaos. Traditionally, it was believed that as a quantum system loses coherence (transitioning from quantum to classical behavior), the signatures of quantum chaos are suppressed. However, recent research challenges this notion, suggesting that quantum chaos can persist even in partially coherent systems. The concept of Krylov complexity can act as a probe for the integrable or chaotic nature of a system. It's related to how the system evolves over time and can indicate transitions from regular to chaotic behavior. For systems that can switch from regular to chaotic behavior by tuning interaction parameters, complexity defines a new time scale. This time scale marks the transition from regular to chaotic dynamics.

What Happened on the Way to the Fall into Classicism?

Chaos theory in quantum chaos takes its analogical cue from classical chaos theory. Classical chaos theory symbolized by the butterfly effect looks deeper into initial infinitesimal variables to discover how a butterfly flapping its wings in Texas causes a tornado in Brazil. This is a dive into complexity. At what point does complexity turn into pure chaos? In classical, cause and effect, history there is no such point. The apparent semblance of a 'point' like that is due to our inability to understand quantum complexity. The classical world is a world where the universe is an exquisitely fine-tuned machine. The universe does not end in chaos. The universe ends in the absolute. Logic is the mechanism of universal truth beginning most prominently in Aristotle (384-322 BC). This metaphysic of absolute order has dominated Western history since the twenty-seven homocentric (having the same center) spheres of

Eudoxus of Cnidus (390-340 BC) who took his theory from Pythagoras (570-495 BC) and Plato (423-348 BC).

The cosmological model of concentric (or homocentric) spheres, developed by Eudoxus, Callippus, and Aristotle, employed celestial spheres all centered on the Earth. In this respect, it differed from the epicyclic and eccentric models with multiple centers, which were used by Ptolemy and other mathematical astronomers until the time of Copernicus.

Eudoxus of Cnidus was the first astronomer to develop the concept of concentric spheres. He was originally a student at Plato's academy and is believed to have been influenced by the cosmological speculations of Plato and Pythagoras. He came up with the idea of homocentric spheres in order to explain the perceived inconsistent motions of the planets and to develop a uniform model for accurately calculating the movement of celestial objects. None of his books have survived to the modern day and everything we know about his cosmological theories comes from the works of Aristotle and Simplicius. According to these works, Eudoxus' model had twenty-seven homocentric spheres with each sphere explaining a type of observable motion for each celestial object. Eudoxus assigns one sphere for the fixed stars which is supposed to explain their daily movement. He assigns three spheres to both the sun and the moon with the first sphere moving in the same manner as the sphere of the fixed stars. The second sphere explains the movement of the sun and the moon on the ecliptic plane. The third sphere was supposed to move on a "latitudinally inclined" circle and explain the latitudinal motion of the sun and the moon in the cosmos. Four spheres were assigned to Mercury, Venus, Mars, Jupiter, and Saturn which were the only known planets at that time. The first and second spheres of the planets moved exactly like the first two spheres of the

> sun and the moon. According to Simplicius, the third and fourth sphere of the planets were supposed to move in a way that created a curve known as a hippopede. The hippopede was a way to try and explain the retrograde motions of planets. Many historians of science, such as Michael J. Crowe, have argued that Eudoxus did not consider his system of concentric spheres to be a real representation of the universe but thought it was merely a mathematical model for calculating planetary motion. 1444

But the 20th century took a sledgehammer to these universal spheres.

Quantum chaos takes classical chaos as a starting point to discover what differences are implied by quanta. In the previous sections I focused on the more pristine walks through the quantum garden. In highly controlled experiments there is a necessity to keep the barrage of flora from overgrowing the garden path. The quantum environment in which we live and move and have our being is really a jungle of exotic and other-worldly branches and roots whose rhizomes pierce the endless sky and sink towards the groundless abyss of alterity. The singularity of the—for lack of better word—'universal' wave function in which our classical horticulture fails in the quantum chaos of the environment cannot find shelter from our nakedness with fig leaves. In this section I want to take a look at what happens when we start to peel back the layers of quantum chaos which underlies the garden of Eden,

> 1. Also called: Garden of Eden Old Testament
> the garden in which Adam and Eve were placed at the Creation
> 2. a delightful place, region, dwelling, etc; paradise
> 3. a state of great delight, happiness, or contentment; bliss 1445

More specifically, what happens when we strip away the shelter of experimental isolation from the quantum environment. The first step into this chaotic darkness is the linear Markovian bath.

> In physics, an open quantum system is a quantum-mechanical system that interacts with an external quantum system, which is known as the environment or a bath. In general, these interactions significantly change the dynamics of the system and result in quantum dissipation, such that the information contained in the system is lost to its environment. Because no quantum system is completely isolated from its surroundings, it is important to develop a theoretical framework for treating these interactions in order to obtain an accurate understanding of quantum systems.
>
> A complete description of a quantum system requires the inclusion of the environment. Completely describing the resulting combined system then requires the inclusion of its environment, which results in a new system that can only be completely described if its environment is included and so on. The eventual outcome of this process of embedding is the state of the whole universe described by a wavefunction. The fact that every quantum system has some degree of openness also means that no quantum system can ever be in a pure state. A pure state is unitary equivalent to a zero-temperature ground state, forbidden by the third law of thermodynamics. 1446

Let's recall the third law of thermodynamics,

> The 3rd law of thermodynamics will essentially allow us to quantify the absolute amplitude of entropies. It says that when we are considering a totally perfect (100% pure) crystalline structure, at absolute zero (0 Kelvin), it will have no entropy (S). Note that if the structure in question were

> not totally crystalline, then although it would only have an extremely small disorder (entropy) in space, we could not precisely say it had no entropy. This tells us about entropy, the disorder in a system. [1447]

What the above quote is telling us is that there is no ‘Garden of Eden’. There is no absolute other than the narrative of classicism. From my previous discussion “Metaphors in Superposition - Energy, Heat, Entropy, and the Direction of Time in Thermodynamic Equilibrium” let’s recall that there is no classical ‘entropy’ in the quantum wave function. There is no ‘heat’. There is no ‘energy’. There is no ‘thermodynamic equilibrium’. These are all classical phenomenological analogies taken up by quantum physicists from Bohr’s correspondence rule which tries to understand classical phenomenon from quantum phenomenon, analogously. Just as zero degrees Kelvin has no ontology, no existence, so zero entropy has no existence in classicism. But zero entropy is a classical metaphor for quantum entanglement. Entropy in the classical world tells us the everything is jumbled up, mixed up, unorganized heat. Information is all mixed together without classical order. This is the arrow of time. But in the classical world entropy ultimately has a logical answer, an answer of noncontradiction, in the machine-like universe of cause and effect. Not so in quantum physics. Spooky entangled systems of the quantum wave function permeating the entire underbelly of the universe have no knowledge of the binary oppositions of order and disorder. The wave function is oblivious to our classical determinations. The wave function can branch as ordered classical systems or not. Its basic excess, its spookiness, is oblivious to origin. Even the idea of a ‘universal’ wave function denotes the universe as an origin. The universe for the wave function has no origin. The universe is a classical determination from our observer effect in branching. Therefore, the universe is a metaphysical historic narrative we tell ourselves. Whether there is a single universe or multiple universes this is more like how many

angels can dance on the head of a pin? The Big Bang, singularity, universe as defined by light which can reach us etc. are classical determination having nothing to do with the imagined expanse of the wave function's scope or determination of its bounds etc. Therefore, from now on I am going to cross out universal[1448] to denote this oddity. The universal[1449] wave function is chaotic. Complexity far exceeds the possibility of a classical limit giving rise to creation, emergence, and novelty. The wave function gives – it gives the possibility of endless branches from the observer effect. Chaos in the wave function is excess to our origin, our classicism, our ready-made ideas. Certainly, this is not the working language of quantum physicists but in my estimation, this is where quantum physics leads us – to the abyss where choice in how and what we observe becomes paramount. The Markovian bath opens the floodgate of the environment and in so doing removes the pristine world of quantum pure states.

> Even if the combined system is in a pure state and can be described by a wavefunction, a subsystem in general cannot be described by a wavefunction. This observation motivated the formalism of density matrices, or density operators, introduced by John von Neumann in 1927 and independently, but less systematically by Lev Landau in 1927 and Felix Bloch in 1946. In general, the state of a subsystem is described by the density operator and the expectation value of an observable by the scalar product. There is no way to know if the combined system is pure from the knowledge of observables of the subsystem alone. In particular, if the combined system has quantum entanglement, the state of the subsystem is not pure. [1450]

It turns out the 'pure' state is not so 'pure'. But some startling results have come out of the flood of chaotic impurity from the environmental onset. There is a phenomenon first observed in

semiclassical physics called electron scattering. This occurs when an electron is exposed to an electrostatic field. It is a chaotic scattering. Electron scattering is a phenomenon that occurs when electrons are displaced from their original trajectory due to the electrostatic forces within matter interaction or, if an external magnetic field is present, the electron may be deflected by the Lorentz force. This scattering typically happens with solids such as metals, semiconductors, and insulators; and is a limiting factor in integrated circuits and transistors. The scattering of electrons has allowed us to understand that protons and neutrons are made up of the smaller elementary subatomic particles called quarks. In classical physics, electron scattering is described by the Rutherford scattering formula, which predicts the scattering angle of a charged particle after it passes through a Coulomb field. However, this formula is only valid for low-energy scattering. For high-energy scattering, the Klein-Nishina formula is used. 1451 The point is that reaching a certain limit in quantum complexity reaches pure quantum chaos wiping out the classical butterfly effect without a trace. In other words, the classical optimism that finer and finer initial conditions will result in more accurate results is proven by quantum chaos to be a relic of history and not consistent with quantum chaos. Currently, there is tremendous attention being given to quantum chaos and how it transitions from/to classical chaos. I have used 'from/to' intentionally because there is a forward and backward transition simultaneously from quantum chaos to classical chaos. While this can be viewed from a classical perspective of temporality, for much of quantum physics it is really state changes. We call this unitarity. But in quantum physics this is an effect of the transition from the nonclassical wave(-like) function to the observer effect - a particle. The term semiclassical is used by quantum physics to describe what I have been referring to as analogies or metaphors between quantum physics and classical physics.

In semiclassical physics Bohr's observation of discrete quantum jumps in the energy levels of bound particles like electrons bound

to a nucleus does not reflect the superposition of all simultaneous states. It represents a transitional state of the observer effect where quanta first appear as discrete. But we call these states a 'cloud' for a reason. They are not like little BBs in an erratic orbit. The electrons are not 'there' in a purely local sense. The word we have for this is 'probability'. The notions of 'probabilities' are conserved in the more pristine, environmental confines of measurement as the observer effect. But as the observer effect begins to transition to more macroscopic, classical perspectives we see that later these 'discrete states' get taken as analogue states because in a visual sense the distance between quantum energy states gets blurred (perhaps in a sense returning to a more predictable form of a quantum cloud). From this perspective, phenomenon appears analog. And classical mathematics extends that metaphor into the mathematics of infinites which is another name for calculus. Infinites appear in our 'realities' because of our history not our *phusis*. Even when we project infinites into the wave function as in 'infinite possibilities' there is a semi-classicism attached to this apperception. What we really perceive in more environmentally friendly 'baths' is chaos which gets historically clothed with our abstract concept of 'infinity'. Just as we saw that analogue classical energy states arise from discrete quanta energy states which again arise from 'infinite, simultaneous possibilities' which arises from pure quantum chaos. Quantum chaos is showing us that causal conditions themselves have no infinite regression as if pure quantum chaos would arise from yet another cause. But the observer effect is a guidepost for semiclassical transitions until we get to pure quantum chaos where the greater environment is allowed to perturb our pristine experimental setups. Currently, there is much research in physics spawned to a large degree in quantum computing into how we can quantify these semiclassical steps back towards pure quantum chaos. The metric of this quantification is called Out-of-time-ordered correlators (OTOCs).

Out-of-time-ordered correlators (OTOCs) are a measure of how

quickly information spreads throughout a quantum system and how chaotic the quantum system is. When a pristine quantum system is opened to the quantum environment the system transitions from the simpler resultant quantum state of the observer effect meaning from wave-like superposition to the observed, branch of a classical measurement value. The relationship between an open quantum system and chaos is a topic of active research in the field of quantum mechanics. According to a recent paper by Paolo Zanardi and Namit Anand, out-of-time-ordered correlators (OTOCs) have been extensively used over the past few years to study information scrambling and quantum chaos in many-body systems. In their paper, they extend the formalism of the averaged bipartite OTOC of Styliaris et al. to the case of open quantum systems. **The dynamics is no longer unitary, but it is described by more general quantum channels (trace preserving, completely positive maps).** More technically, this "open bipartite OTOC" can be treated in an exact analytical fashion and is shown to amount to a distance between two quantum channels. Ok, let me try to interpret.

Quantum channels are communication channels that can transmit both quantum and classical information. In quantum information theory, a quantum channel is a completely positive (CP) trace-preserving map between spaces of operators. In other words, a quantum channel is a pipeline intended to carry quantum information. Quantum channels are used to transfer quantum information in a given environment while preserving the integrity of all transmitted quantum states and resisting classic-ization of the states. 1452 We may not be able to understand all the systems involved in the wave function, but we may be able to understand parts of the systems we call quantum channels. However, while all the systems are assumed to be unitary meaning forward and reversible in time, the limited, isolated channels we have knowledge about are not unitary.

In contrast to quantum gates, which are operations that act on a single quantum system, quantum channels are operations that act

on two quantum systems: the system being transmitted and the environment. Moreover, their analytical form unveils competing entropic contributions from information scrambling and environmental decoherence such that the latter can obfuscate the former. To elucidate this subtle interplay, they analytically study special classes of quantum channels, namely, dephasing channels, entanglement-breaking channels, and others. Finally, as a physical application they numerically study dissipative many-body spin chains and show how the competing entropic effects can be used to differentiate between integrable and chaotic regimes. 1453 In other words, as the wave function breaks down into classicism their previously entangled states (referred to pre-classically as entropic) begin to break down or decohere into our classical 'world'. But the chaotic universal1454 wave function is oblivious to our sense of 'reality'. By 'reality' I am referring to the symbiotic (meaning unitary or forwards/backwards) measure of our classical 'reality' and how quickly information spreads to/from a quantum system. The markers of the OTOC are able to some degree characterize these states of transitions from our classical observations concretized in the macroscopic world of commonsense to/from how chaotic the quantum system is. By writing "how chaotic the quantum system is" I am referring to the nonlocal scrambling of information. The "the nonlocal scrambling of information" 'becomes' our world, our history, our narrative. The 'spooky' in all this comes about when we take this as physics, as odd, Frankenstein-like stuff. The spooky is extreme excess. The 'spooky' of radical alterity is letting go of narrative, of historic totalizing in the unavoidable face of responsibility.

Patterns in Complexity

A fractal is a never-ending pattern. Fractals are infinitely complex patterns that are self-similar across different scales. They are created by repeating a simple process over and over in an ongoing

feedback loop. Driven by recursion, fractals are images of dynamic systems – the pictures of Chaos. Geometrically, they exist in between our familiar dimensions. Fractal patterns are extremely familiar, since nature is full of fractals. For instance: trees, rivers, coastlines, mountains, clouds, seashells, hurricanes, etc. Abstract fractals – such as the Mandelbrot Set – can be generated by a computer calculating a simple equation over and over. 1455

Fractal mathematics and the quantum wave function share intriguing connections, despite their seemingly disparate realms. In quantum physics, a wave function (often denoted by the Greek letters ψ or Ψ) mathematically describes the quantum state of an isolated system. It represents the probability distribution of a particle's position, momentum, or other observable properties. Wave functions are composed of complex numbers and provide a way to understand the behavior of particles at the quantum level. They exhibit both wave-like and particle-like characteristics. The Born rule allows us to convert these complex probability amplitudes into actual probabilities. Essentially, the squared modulus of a wave function gives the probability density of finding a particle in a specific location. Wave functions can also incorporate additional degrees of freedom, such as spin or isospin, making them versatile mathematical constructs. Fractals are found everywhere in nature. Here are a few examples, 1456

- **Romanesco Broccoli:** This vegetable grows in a golden spiral, a pattern based on the golden ratio. The spiral gets wider by a factor of φ for every quarter turn it makes. The broccoli's tendency to produce buds at an accelerating rate causes this spiral pattern and resulting conical shape.
- **Pine Cones:** Pine cones are woody, scaly fruits that dangle off evergreens and serve as the trees' seed-bearing organs. The satisfying spiral of their scales reflects the seeds they protect. They close tightly when it's damp or

cold, then open when it's optimal for seeds to spread in the wind. Again, the fractal design is caused by accelerated growth.

- **Succulents:** In plant biology, fractal designs are called spiral phyllotaxy, which refers to the arrangement of leaves on a plant. The upturned, coiling leaves of the spiral aloe (Aloe polyphylla) and some Echeveria varieties help funnel rainwater to the plant's core and prevent top leaves from shading out bottom leaves. The spiral pattern of both plants and fingerprints occurs for the same reason, which is to relieve stress. Forces acting in opposing directions cause skin and plant tissue to buckle inward as it grows.
- **Ice and Snow:** No two snowflake designs are alike, but many represent fractals in that the branches of a snowflake spawn their own side-branches, and so on. The snowflake could continue on like this for an eternity, growing the size of Earth itself, if it weren't to stop accumulating moisture and, eventually, melt away. The most famous fractal snowflake pattern is known as the Koch snowflake, stemming from one equilateral triangle forming another and another and another. 1457

Mathematical physicists have discovered that chaotic fractal patterns exist in the quantum realm. Semyon Dyatlov is a highly regarded 'mathematical physicist' who studies the very odd relationship of quantum chaos and fractals. He tells us,

> "Say you have waves bouncing off, and everything else escapes but you have a system — say the inside of a bowl — where these classical trajectories never leave. The thing that I study is a situation where you have in your system a fractal set of trapped trajectories," he says.
>
> These trapped trajectories form a fractal set that appears

> “out of nowhere,” he says. “The fact that fractal sets appear from this was known well before my work, but it was still a surprise to me when I looked at it. Here, a fractal set appears naturally in a problem where you didn’t put in a fractal set.”
>
> That work led to his development of what he terms the “fractal uncertainty principle.” The classical uncertainty principle says you can’t pinpoint both the position and momentum of a quantum particle. Dyatlov posited a form of this principle for this fractal set of trapped trajectories.
>
> “I figured out one might be able to solve this wave decay question — this question about partial differential equations, about classical-quantum correspondence, about wave dynamics, and chaotic dynamics — but the component you need is this new kind of fractal uncertainty principle,” he says. 1458

These patterns emerge when the waves associated with particles (such as electrons) interfere with each other. Fractals exhibit self-similarity across different scales, and their intricate structures can be found in various natural phenomena, including quantum systems. While fractals are typically associated with chaotic and nonlinear behavior, their presence in quantum physics highlights the underlying complexity of the microscopic world. These fractal-like patterns may arise due to the intricate interplay of quantum probabilities and wave interference. Fractals and quantum wave functions both touch upon the concept of particle-wave duality.

Particle-wave duality suggests that particles (such as electrons) exhibit both particle-like and wave-like behavior. Fractals, with their self-similar patterns, resonate with this duality. Nonlinear equations, akin to fractals, can describe the behavior of particles in quantum systems. This connection underscores the fundamental nature of both fractals and wave functions. While fractals and quantum wave functions operate in distinct domains—one in mathematics and the other in quantum physics—their intertwined

properties reveal the fascinating interplay between order and chaos at the smallest scales of our universe.

Fractals like rhizome are chaotic. They are not grown from Concept. They have no guiding formula, no structure, which perpetually replicates itself in the absolute. Fractals feed back into themselves in a way which creates ever new patterns never returning to the same. In an analogous way, the haziness of we and me, our classical historic narratives, which defy sameness. Ever falling from the environmental wave function's immense chaos into our classic historic narratives and, as rhizome, into ever-emergent novelty, mathematics which knows no origin or destination of itself, repetitively back into itself as if to establish itself once again for the first time from chaos. Fractals undo themselves incessantly. Their mathematical repetition feigns a temporality growing skyward, evolving towards a future of completion, a *telos*, as infinite potential. But their classical actuality their plurality of me/us narratives disappears in a dark ground in its own mesh of roots of ever-growing complexities which finds its limits and novelty in chaos. Coming-into-being, the *genet'* of genetics, must alter itself not from origin and evolution but from accidental novelty.

Information and Entropy

From a classical perspective we never think that information is related to volume. We typically think that information is in another realm than the physical world. This is our history which provides that narrative. Actually, according to quantum gravity theory, information is as much as part of the 'physical world' as our bodies. Information resides in physicality not in some metaphysical 'reality' which visits physicality. Even the idea of 'physicality' at least from the earliest time in later Latin interpretations of Aristotle has been handed down to us as yet another binary dualism. We think 'physical' and its totalizing opposite as not-physical which could mean, beyond (meta), first principle as origin/rule, spiritual, mind,

etc. But actually, there is a limit to how much information you can stuff into a volume. By information we mean bits of information which may reflect descriptors of quanta, characteristics, or functions like location, momentum, charge, spin, etc. The maximum information you can store in a cubic centimeter (1 cm^3) of space is proportional to the area of its boundary.

> To cut a long story short the maximum information that you can store in 1 $cm^3 = 10^{-6}\ m^3$ of space is proportional to the area of its boundary. For a uniform spherical volume, that area is:
>
> $A = V^{2/v3} = 10^{-4}\ m^2$
>
> Therefore, the maximum information (number of bits) you can store is approximately given by:
>
> $S \sim A/A_{pl}$
>
> where A_{pl} is the Planck area ~ $10^{-70}\ m^2$. For our 1 cm^3 volume this gives Smax ~ 10^{66} bits.
>
> Of course, this is a rough order-of-magnitude estimate, but it lies in the general ballpark and gives you an idea of the limit that you are talking about. As you can see, we still have decades if not centuries before our technology can saturate this bound! [1459]

This information density even applies to blackholes. More on that later. The point is somewhere around 10^{66} bits of information per one cubic centimeter. That is a lot of information, but the number is a finite limit not infinite. This is called the Bekenstein bound. [1460]Also, note that some information may not be accessible to us as in environmental information affecting the quantum wave function in superposition or simply other dimensions or many-worlds/universe. It does not so much matter what you think about it except that it is inaccessible to us. It exceeds us as an externality which our history cannot capture. Additionally, information can reflect relationships like cause and effect, or it can be stochastic

(randomly determined; having a random probability distribution or pattern that may be analyzed statistically but may not be predicted precisely) or as basic constants like:

e is the elementary charge $1.602176634 \times 10^{-19}$ C

h is the Planck constant $6.62607015 \times 10^{-34}$ J·Hz^{-1}

ħ is the reduced Planck constant, ħ = h/2π ($1.054571817 \times 10^{-34}$ J·Hz^{-1} or $1.054571817 \times 10^{-34}$ J·s)

c is the speed of light 299792458 m·s^{-1}

ε0 is the electric constant $8.8541878128(13) \times 10^{-12}$ F·m^{-1}

Or the fine structure constant which is dimensionless at 0.0072973525693 with a relative uncertainty of 1.5×10^{-10} [1461]

Then there is quantum information. Quantum information refers to the information encoded in the state of a quantum system or the wave function in superposition. It is a fundamental concept in quantum information theory and plays a crucial role in quantum computing, communication, and cryptography. Quantum information can be manipulated using quantum information processing techniques. Just like classical information, information which is observed or collapsed into classical information, is processed using bits, quantum information deals with qubits. One of the key challenges in quantum information is that due to the uncertainty principle, non-commuting observables cannot be precisely measured simultaneously. A quantum state cannot contain definitive information about both non-commuting observables. [1462]

Information can be orderly or chaotic. Chaotic may be disorderly but it exceeds that designation as for example information which we do not have access to, or exformation entangled with a blackhole on the other side of the universe, or entropy meaning a thermodynamic quantity representing the unavailability of a system's thermal energy for conversion into mechanical work, often interpreted as the degrees of disorder or randomness in the system. But ‘degrees of disorder’ or ‘randomness’ is information which has no apparent organization, it is chaotic meaning the decidability is lacking. Is chaos simply meaningless, or

disorder, or could it be a limit to the amount of complexity? Is there an information limit in quantum complexity? If so, is it related to a limit of entropy?

Von Neumann entropy is a measure of quantum information. It quantifies the uncertainty or disorder in a quantum system.

The entropy of a quantum system is related to the number of possible quanta states it can occupy. For a pure quantum state, the entropy is zero, while for a mixed state (with superpositions), the entropy is positive. [1463] The Bekenstein bound, which originates from black hole physics, limits the amount of information that can be stored within a spherical volume to the entropy of a black hole with the same surface area. Quantum information theory connects the technical definition of entropy (such as Von Neumann entropy) with the broader computational aspects of quantum information processing.

In classical information theory, entropy (measured in bits) represents the uncertainty associated with a random variable. For example, the entropy of a fair coin toss is 1 bit. In quantum information theory, the concept of entropy extends to quantum systems. The entropy of a quantum state reflects the uncertainty about its properties. While classical entropy deals with discrete probabilities (e.g., coin flips), quantum entropy accounts for continuous probabilities arising from superpositions of quantum states. [1464]

In superposition there isn't a strict limit on the complexity of quantum superpositions where chaos emerges. But our practical abilities to deal with vast seemingly chaotic complexities and complexities which we can find emergent qualities whose basis is in quantum chaos leaves us choices with how we set up our experiment and by extension, our life. We can follow the classical route where positivism rests in empirical statistical restraint from further speculation or rationalism which positively affirms that reason underlies apparent chaos or philosophical or religious metaphysics which rest in absolutes, or in responsibility imposed

upon us from externality which exceeds or egoist freedom and places a demand on us. More on that later.

Quantum Entropy is Very Different from Classical Entropy

When we refer to quantum entropy, we are referring to a quantum system in superposition described by the quantum wave function. In classical mechanics entropy is a measure of disorder or randomness in a system. In classical thermodynamics, entropy tends to increase over time due to the second law of thermodynamics, leading to the concept of the arrow of time. However, in quantum mechanics, things are very different. In quantum statistical mechanics, the von Neumann entropy extends the concept of entropy to quantum systems. It quantifies the uncertainty or lack of information about the state of a quantum-mechanical system. When a quantum system is in an ideal pure state (such as an electron in a superposition), its entropy is zero. This is because a pure state is precisely defined, and there is no randomness or uncertainty associated with it. In contrast, when we consider mixed states (such as a statistical ensemble of quantum systems), entropy comes into play. The entropy of a mixed state quantifies our lack of knowledge about the individual ideal pure states within that ensemble. Mathematically, it's related to the density matrix of the system.

Quantum interference refers to the phenomenon where quantum waves (such as wave functions) combine and either reinforce or cancel each other out. It occurs when different quantum states interfere constructively (leading to enhanced probabilities) or destructively (leading to reduced probabilities). Examples include the double-slit experiment, where a single particle exhibits wave-like behavior and interferes with itself as it passes through two slits. Quantum interference is not quantum entropy, but quantum interference can impact the entropy of quantum states and not in the way you might think it would. Recent research has shown that quantum interference can suppress the entanglement entropy

between particles and antiparticles in certain scenarios. Entanglement entropy is related to the entanglement between quantum particles and is equal to the Gibbs entropy of the produced system. By studying the effect of quantum interference in sequences of electric pulses, scientists have observed a *decrease* in entanglement entropy, the opposite of what would happen in classical interference.

In quantum superposition quantum entropy is related to the amount of entanglement of the system. When two or more particles become entangled, their combined state cannot be expressed as a simple product of individual states. Because of this the entangled system has higher entropy or entangled informational disorder due to the lack of a simple product of individual states for entangled particles. Pure states have no entropy because they are not entangled. Mixed states and states in an environmental 'bath' are entangled to more or less degrees which, in a classical sense, is semiclassical, an analogy or metaphor, of something which we call entropy in classicism. When a quantum system interacts with its environment (like air molecules or stray photons), it undergoes decoherence. Decoherence, the observer effect, leads to the loss of quantum coherence and the emergence of classical behavior also called wave function collapse. As a result, entangled entropy increases in the quantum system's transitions from superposition to a mixed state. It is important to understand that superposition itself doesn't inherently involve entropy at all. Entropy is a classical condition which is a measure of disorder in a classical system. However, if we had all knowledge of the wave function like LaPlace's demon our knowledge would be complete meaning we would understand quantum wave function 'reality' strictly in terms of superposition. Quanta in superposition will inevitably interact with the 'environment', meaning information we have no knowledge of, to some degree no matter how much experimenters try to isolate an experiment. The introduction of entangled information, exformation, we cannot account for is one reason for

quantum entropy. Quantum interference introduced by departing from an experimental pristine environment is a measure of informational complexity. Quantum systems in superposition are a delicate dance between information we can intentionally introduce in experimental design and inevitable unaccounted for complexities which introduce informational chaos. Our ignorance of informational chaos is quantified by quantum entropy. This is a result of the fall into classicism which means informational branches are forever lost to us.

The Quantum Wave Function's Information Requirement

The Schrödinger equation has time independent states and time dependent states.

> Physical systems are divided into types according to their unchanging (or 'state-independent') properties, and the state of a system at a time consists of a complete specification of those of its properties that change with time (its 'state-dependent' properties). To give a complete description of a system, then, we need to say what type of system it is and what its state is at each moment in its history.[1465]

Quantum mechanics uses a complex mathematics called Hilbert space which uses numbers, sets, and complex vectors to describe a state. Operators are operations of a state which is mapped on to itself. Perhaps another way to think about this is the different kinds of ways states can exist. States are static. However, there are dynamics which govern how the states go from one state to another state.

There are two types of dynamics:

- Type 1 – Schrödinger's equation: Static states are **deterministic**, **unitary**, and **linear**. What do I mean?

Determinism means a state at one time must go into a unique state at another time. **Unitary** means the operators which map any particular state onto itself must be linear. The operators cannot be discontinuous or just jump to a condition which must simply be asserted without a mathematical transition. **Linear** means there is a linear relationship between the two states. In other words, one state cannot jump discontinuously into another state. The transition from one state to another cannot be discontinuous or just jump to another state willy-nilly.

- Type 2 – Born's Rule: This is the observation or measurement problem. This is the probability function given by the wave function collapse, the pilot-wave theory of which we can never know anything about its 'local variables', or information updating and branching. 1466

The time dependent Schrödinger equation has a time evolution operator. The time evolution operator governs how a given quantum state changes over time. For the quantum wave function to be successful, to predict a future quantum state, the time evolution operator must be unitary, two things must be true:

- It means future changes are uniquely determined by the time evolution operator
- It means the inverse is also true or that it works in reverse time 1467

The complementarity principle defines the spookiness of quantum mechanics. As we know according to Schrödinger, *the characteristic trait of quantum mechanics* is entanglement. Therefore, the basis of complementarity is entanglement.

> To summarize, our hybrid interpretation views the quantum state as a concise encapsulation of the information that we possess about a quantum system, and recognizes that the various forms that this information can take depends on our conceptual identification of component subsystems. The Hilbert space dimension of the system appears to be the key objective property that constrains the spectrum of valid conceptual decompositions. Each of these decompositions is, in turn, thought to correspond to the existence of one or more complementarity relationships between the designated subsystems and the various possible multipartite correlations that may exist between them. Unlike in classical systems, information is not restricted to be encoded solely in the individual subsystems, but can also be directly encoded in correlations; all the while being subject to tradeoffs governed by the relevant complementarity relations. From this point of view, complementarity may be identified as that part of quantum theory where objectivity (Hilbert space dimension) and subjectivity (the arbitrary conceptual distinctions which we impose on the system and the information that we possess about them) intersect.[1468]

The bottom line is for quantum mechanics information must be preserved. Information cannot be lost.

The Conservation of Information Requirement

Information is very important in the quantum world. In the classical world information can be copied and deleted at will. Not so in the quantum world. In the quantum world information cannot be created or destroyed.

> In the classical world, information can be copied and deleted at will. In the quantum world, however, the conservation of

> quantum information means that information cannot be created nor destroyed. This concept stems from two fundamental theorems of quantum mechanics: the no-cloning theorem and the no-deleting theorem.[1469]

In addition to the no-cloning theorem and the no-deleting theorem in quantum mechanics there is another theorem called the no-hiding theorem. The no-hiding theorem tells us that any information lost in a quantum system must be residing in another quantum system somewhere in the universe. Another way to think of this is, in a quantum system information cannot be lost to the environment.[1470]

The Riddle of Spookiness

With all this spookiness going on, how is it we do not wake up in a new world every day? Well, maybe we do but we just tell ourselves it is the same ol', same ol'. In any case, it appears we do not start everyday as a newborn. We certainly have a seemingly reliable feeling of certainty. So, what gives?

First, according to quantum physics, the 'feeling' of stability and certainty has to do with informational updating, the collapse of superposition into what we think as 'reality' not some historic metaphysical notion which gets taken up in everydayness as merely obvious to common sense. We have even coined an essential term for information updating which gives us a veneer of objectivity which isn't spooky – change.

Atoms are stable enough to make everything that is, 'is'. Well, sort of, we have found ingenious ways to cover over one glaring question about existence – what underlies our everyday notion that we think simply as 'change'? The ol' saying is that the only thing that stays the same is change. On the level of chemistry and atoms change is essential. Chemistry and atoms are always in perpetual transformations. But this is not your father's notion of change. What

lurks behind the notion of change?

Our minds are magnificent filters collapsing us into ‘reality’. Our bodies may be breaking down as we get older, but our minds simply adapt, collapsing as on-going narration, updated information, to accompany our changing bodies and attitudes. Adaptation is not merely biological obliviousness both to the world and our societal embeddedness. To the contrary, as Homo sapiens, the more we transform ourselves into antisocial, transactional narcissists, the more pathological we become and the more detrimental to further survival and adaptations of our species. Climate change is already evidence of our inability to adapt to the threat of species level extinction. Normality and even sanity makes no sense without the Other (Autrui): others, family, community, etc. All of this is subsumed under our word’s history, language, and culture. The extent to which we ‘are’ historical is a uniquely incredible gift we have which defines us, makes us who we ‘are’, but also threatens us by universalizing our notions of ‘true’ reality. ‘Truth’ as historically validated gets easily translated from universal to emotively personal values by the mechanism of modernity’s sense mechanisms strained through the common sense of historic logic, dialectically introduced as a kind of inner dialog with ourselves. Our ‘are-ness’ is existentially threatened and negated by our ‘not-are-ness’, death. Even taxes seem to be uncertain for some folks, but death is always certain for all folks.

Angst is gnawing fear and anxiety that we certainly will lose our ‘are-ness’. We fear all ‘reality’ will melt away because we simply blink out one day. Perhaps, if we take the deepest and most extensive ramifications of physics as *phusis*, we blink out incessantly in moments of superposition from dazing wakefulness to sleep every day. Our brains tear down and rebuild neurons every time we remember, re-narrate, or think of something. Our entangled mind/body systems cohere and decohere with all kinds of other entangled systems, people, animals, environment, without any regard to our in-breed abstract notions of space and time, cause and effect. Even

more so, radical excesses are prohibited by our historic narrations molded into values falling into domains of consciousness and reason. Our values tend to reason and justify any radical excesses as contrary to security, anti-light, light's antithetical twin and nemesis darkness. This kind of reasoning seems to have a lot in common with what we *value* as 'personal' (the 'me' of light) and the bad faith other (the 'not-me' of darkness). But more appropriately, could it be that radical excess is not something as bizarre as we imagine? After all consciousness itself branches from the wave function. Could the unconscious also have some relationship to what quantum physics calls superposition? Well, at least I am not the only one that has thought about this.

Consciousness Collapse

There are some physicists who have explored the relationship between quantum mechanics and consciousness. One such example is a paper by David Chalmers and Kelvin McQueen titled "Consciousness and the Collapse of the Wave Function". They discuss the problem of quantum reality and the mind-body problem, and explore the idea that consciousness is related to the collapse of the wave function. Another paper by the same author, titled "Consciousness and the Collapse of the Wave Function", discusses the idea that consciousness collapses the quantum wave function. They combine a mathematical theory of consciousness with an account of quantum collapse dynamics to develop this idea.

> The central motivations for the consciousness-collapse view come from the way it addresses these problems. Where the problem of quantum reality is concerned, the view provides one of the few interpretations of quantum mechanics that takes the standard measurement-collapse principle at face value. Other criteria for measurement may be possible, but understanding measurement in

terms of consciousness has a number of motivations. First, it provides one of the few non-arbitrary criteria for when measurement occurs. Second, it is arguable that our core pretheoretical concept of measurement is that of measurement by a conscious observer. Third, the consciousness-collapse view is especially well-suited to save the central epistemological datum that ordinary conscious

observations have definite results. Fourth, understanding measurement as consciousness provides a potential solution to the consciousness-causation problem: consciousness causes collapse.[1471]

Sir Roger Penrose (OM, FRS, HonFInstP) was born August 8, 1931. He is an English mathematician, mathematical physicist, philosopher of science and Nobel Laureate in Physics. He is Emeritus Rouse Ball Professor of Mathematics in the University of Oxford, an emeritus fellow of Wadham College, Oxford, and an honorary fellow of St John's College, Cambridge, and University College London.

The origin of consciousness is one of the greatest mysteries of science. One proposed solution, first suggested by Nobel Laureate and Oxford mathematician Roger Penrose and anesthesiologist Stuart Hammeroff, at the University of Arizona, in Tucson, attributes consciousness to quantum computations in the brain. [1472]

Physicists have even conducted quantum experiments to investigate Penrose's ideas. So far they have not validated them experimentally, but further experiments are in process. Certainly, these ideas are still being debated and are not universally accepted. However, they provide interesting insights into the relationship between quantum mechanics and consciousness. [1473]

Certainly, these ideas are mere speculation at this point.

However, since the quantum wave function is widely known and accepted as underlying and giving rise to all our classical 'realities', it does not seem unreasonable to think that the collapse of the wave function might have a role in what we call self-consciousness? Perhaps the self is set as the foreground on a background deemed unconscious. The unconscious would then be the state of lived superposition, no less, no more. Whatever 'intelligence' *is*, it may have underpinnings on absolute uncertainty, on chaos. I am not thinking of the caricature of chaos which aids reason in simply dismissing chaos as opposite to order and therefore nonsense. The historic bipolar duality of order and disorder is a historic frame where disorder is readily associated with darkness, absence, the 'not' of truth and justice whereas order is readily associated with light, presence, and truth. This duality has no way to understand chaos as branching classically into binary dualities and yet, far exceeding them. The exhaustion of these historic values in 19th existentialism became irretrievably intertwined with the *Übermensch*, superman, where individuality transactionally determines and translates good and evil as 'healthy' narcissistic rage taken up by the creator of new origins in the play of ego for Nietzsche.

> The very word "illusion," Loewald (1974, p. 354) reminds us, derives from the Latin ludere, to play. Healthy narcissism reflects Nietzsche's subtle dialectical balance between illusions and reality; illusions concerning oneself and others are generated, playfully enjoyed, and relinquished in the face of disappointments. New illusions are continually created and dissolved. Winnicott (1971) has described the important connections between healthy illusion, play, creativity, and cultural phenomena in general.[1474]

Contrarily, behind the smoke and mirrors of this obfuscating curtain where drama plays in the stage as 'historic' and 'individual',

there are unaccounted-for and obscured byways which remain as spooky chaos informing us about non-classical uncertainty.

Alice on Knowing and Certainty

What if 'knowing' itself falls from the riddle of superposition into classicism's certainties? Could it be that behind the scenes, branching worlds fall into an Alice's Wonderland where things are often not what they seem. Alice drinks a potion that makes her shrink to a tiny size and eats a cake that makes her grow to an enormous height. And in spooky complementarity a particle is a wave, and a wave is a particle. The inside of a blackhole is on the outside and the outside of the blackhole is on the inside. Locality is a pill Alice took called history. The self and the Other (Autrui), the 'me' and 'them' are historically caught in a Cheshire Cat that only appears in halves, reductive narratives which elevate 'my' passions in light and glory and at the same time the Other (Autrui) of 'me' to invisibility and darkness. All the while we must attend the mad tea party of death which never ends. Our historic narratives dictate our day to day commonsense while any such thing as a radically other can only remain yet another simply equivocation of the same.

The values we nurture about ourselves, and others make us believe we have certainty and therefore security. But could it be that all our certainties have an unaccountable excess from which they flee? The more we retreat from radical alterity, the more we abandon ourselves to ourselves. Alterity is chaos to 'me' as living subject. Subjectivity does not belong to 'me' as origin, as the historic fiction of metaphysical self-rule and sole authority. Nevertheless, the subject is the allowance of 'me' to hold sway in decision, the observer effect in collapse in which the many-worlds are many selves. 'Me' is a singularity which cannot be made commensurate to the Other (Autrui) except in totalizing the Other (Autrui) to 'my idea of the other'. 'Me' is the subject's retreat from abyssal, radical exteriority terminating into what is taken

historically as commonsense, as the self in a comfortable metaphysics of ‘matter’ which is neutrality, substance, the universal it-ness, of mechanistic physics and modernity. But the self does not remain in the historically framed paradigm of mere sensed ‘information’ easily.

Could it be that the subject arouses itself as embodiment broken up from the nudity of his or her face, diachronous (a radically other temporality) from my lived space, my lived time, my lived place. Could it be that the radical alterity of her or him that faces me from a chasm anarchic to me, not in my origin, speaks to me from a gap which cannot be bridged in my *eidos*, my idea, my wave function branching as self, as my unitary time evolution? Is it possible that subjectivity is responsible even in its retreat from radical alterity only into its own echo of itself? Can the self even choose responsibility from the radical alterity of the Other (Autrui) who faces me? Could it be that the radical alterity of the Other (Autrui) is before my freedom to choose the imposition of responsibility? Likewise, for state reduction ‘me’ choice is not optional. I can retreat from responsibility as transactional narcissism or I can face responsibility to the Other (Autrui) which cannot belong to ‘me’ and my idea, my *eidos* (idea) in which origin and values are driven from *logos* meaning to “*put in order, arrange, gather, I choose, count, reckon, I say, speak*"[1475] taken as ‘my’ lights and darknesses. Responsibility is before either ‘me’ thrown back, echoing myself as Narcissus’ admiring Echo as mine, becoming the deadened gaze of Orpheus or indebtedness to the Other (Autrui) which cannot be repaid. In either case responsibility is beneath in the abyss.

But ego as the determinative of ‘me’ is rooted from abyssal retreat from radical alterity branching as ‘my worlds’, as rhizomic. Rhizomic is the adjective of rhizome.

> …rhizome (/ˈraɪzoʊm/; from Ancient Greek ῥίζωμα (rhízōma) 'mass of roots', from ῥιζόω (rhizóō) 'cause to strike root') is a modified subterranean plant stem that sends out

> roots and shoots from its nodes. Rhizomes are also called creeping rootstalks or just rootstalks. Rhizomes develop from axillary buds and grow horizontally. The rhizome also retains the ability to allow new shoots to grow upwards.[1476]

The tree of life is nourished where my freedom ends and radical alterity begins, where the unpayable debt to the Other (Autrui) begins. The radical alterity of him or her which faces and speaks to me is nourished in responsibility towards a time not my time a place not my place, the he or she which faces me. The freedom of 'me' can universalize itself in retreat from alterity or respond to the Other (Autrui) who exceeds even, and especially, the 'not me'. The diametric and diabolic duality which universalizes into 'me' ignores what exceeds beyond measure 'not me'. The 'are' of 'me' branches as living world built upon decisions which universalizes. Responsibility gives deference and obligation to the radical alterity of the Other (Autrui). This is *etz chaim,* the tree of life, concern for an uncompensated excess of the radical alterity of the Other (Autrui).

Phusis was intuited by the ancients as groundlessness, without origin, as *apeiron*, without limit. This intuition was taken up and refined by history as the 'is', Being and Concept, the absolute. Modernity refines it as anonymous, as the 'it' to which everything resolves. Yet, physics in the 20th century transforms the Gordian Knot of pure 'isness' towards spookiness. But spookiness cannot find existence in classical physics, in classicism. Spookiness rests uneasy as in the classical ghost which haunts history. The 'me' walking to and fro upon the earth isolated in the futility of death in vacuous thirst which the subject contained within itself, cannot quench. Nietzsche's choosing becoming, becomes the death stare of Orpheus' untimely gaze back into what can never 'be' – Eurydice. Turning back in my freedom, ever inwards, towards Hades, she does not await us, only the death stare of self-annihilation awaits us. Indebtedness to the face of the Other (Autrui) could never be

made commensurate in my time, my space. There is no passive, ghostlike gaze which can stand for, or in, the alterity of the Other (Autrui).

> It is a passivity more passive still than any passivity that is antithetical to an act, a nudity more naked than all "academic" nudity, exposed to the point of outpouring, effusion and prayer. It is a passivity that is not reducible to exposure to another's gaze. It is a vulnerability and a paining exhausting themselves like a hemorrhage, denuding even the aspect that its nudity takes on, exposing its very exposedness, expressing itself, speaking, uncovering even the projection that the very form of identity confers upon it. 1477

We have no choice even in our certainties to our responsibility, to radical alterity, the Other (Autrui) who stands before us even without 'my' determinations, in recognition of their otherness and my debt to what cannot be repaid. I am not a Christian and have no theological certainties about a metaphysical 'God'. Ancient intuitions of p*husis* lost by Frankensteinian mechanics of history can never be origin as it portends, can never exist in the insularity of 'my spacetime'. In the demise of all historic epochs of Being, in the bare nakedness of the face of the Other (Autrui), there is no relief from choice. The radical alterity of the Other (Autrui) cannot end in spooky physics but must begin in responsibility to the Other (Autrui). I will not elucidate here on Levinas' quote below from his later work "Otherwise Than Being or Beyond Essence" but this work is a most beautiful articulation of how radical alterity and ethics dislodge much of dominant philosophical history. In an oddly similar way, I see classical sciences, most clearly in classical physics, obscuring aspects of *phusis* which intuitively hinted at these possibilities but could not bring them into the violence and desperations of ancient cultures. The harshness of ancient survival quickly overcame intuitive notions towards Levinas' and quantum

physics' radical alterities and were further obscured by subsequent histories. Levinas goes even further in stating that he believes this obscurantism totalizes, mediates, and *is* the source of violence to the Other (Autrui), the very practical terms of the she or he we face every day.

> Contracted as a relationship with the Good, responsibility precedes and makes possible the theoretical will, or the ontological appropriation. It is first an ethical structure. This book is entirely a labor of articulating the inevitably strange, nonobjective and non-ontic, but also non-ontological, terms with which the original form of responsible subjectivity has to be described. Levinas's attention here is not on the experiences in which an ethical essence of subjectivity could be intuited, or out of which it could be deduced. He does not seek this ethical and non-theoretical intention of subjectivity in special moral experiences, but finds it immediately in the theoretical intentions, the critical and rational intentions of cognition, and therefore in language and in philosophical language in particular. For Levinas's project what is difficult is not to locate the place where ethical responsibility is in force; as soon as one is in philosophy, indeed as soon as one is in language, one is in that place. But the difficulty is that every theoretical and ontological intention of philosophy dissimulates the ethical subjectivity, just by formulating it in its terms, which are those of theoretical and ontological intelligibility. Even the nonrepresentational language which seeks to articulate the movement of Being itself in the presented or represented beings dissimulates the subjective movement that before disclosing Being exposes itself to the Good. That the formulation of subjectivity in terms of the objective, or already of the thematizable, or even of Being, is already this dissimulation is what forces Levinas to speak of a sphere which is not that of being while not being nonbeing

— which is otherwise than Being. [1478]

I would add that though ancient histories obscured intuitions of radical alterity, the seeds of democracy and benevolence were never snuffed out completely by the classical world. More on this in the later part of this book.

Radical externality is not merely physics. It cannot be taken up or completed from *phusis'* physics and philosophy. It cannot be merely 'objective science' or ethics subjugated to rationalism which is altruism. The encounter with the face of the Other (Autrui) is a path away from the hallowed echo of Being. This avenue will take us towards the way of Emmanuel Levinas later.

What is the Reach of Information, Exformation, and Exteriority?

Information has taken some amazing new turns in the recent history of physics, computer science, and complexity theory. As it turns out "*the flip side of a high degree of order or informational content is, roughly, a high degree of disorder."* [1479] Information and disorder have an interesting dance as both order and disorder move in and with exformation. If information is both causal and uncaused (as exformation), then the yawning gap is all possible, potential information given anarchically is not what is conventionally thought as 'disorder' but is really chaos. In physics this 'an-archy', without origin, is named in one of its most certain contingencies of our spacetime. The quantum vacuum of virtual particles encompasses both existence and non-existence, both causal and uncaused information. Vacuum energy is the fabric which underlies spacetime, but it is barely existent as virtual particles popping in and out of existence. Distance in spacetime is not determined by the abstract notion of linearity and locality. Rather, in the discussion on the entangled definition of distance we saw that distance had to do with the density of entangled systems. We also saw that spacetime appears to be an emergent phenomenon of entanglement. The

commonly used math of relativity defining the vacuum energy of spacetime is de Sitter space with a negative cosmological constant. Anti-de Sitter space (AdS) simply has a positive cosmological constant. Remember one example of the duality of complementarity is the wavicle. We find this complementarity in many different quantum phenomena as we have already discussed. The complementarity of AdS and Conformal Field Theory (CFT) shows that regions of space on the AdS duality are tightly coupled entangled systems on the CFT side.

> But if space is emergent, entanglement's ability to persist over large distances might not be terribly mysterious—after all, distance is a construct. According to studies of the AdS/CFT correspondence by physicists Shinsei Ryu of Princeton University and Tadashi Takayanagi of Kyoto University, entanglement is what produces distances in the AdS space in the first place. Any two nearby regions of space on the AdS side of the duality correspond to two highly entangled quantum components of the CFT. The more entangled they are, the closer together the regions of space are.[1480]

Susskind puts it like this,

> "What is it that holds the space together and keeps it from falling apart into separate subregions? The answer is the entanglement between two parts of space," Susskind says. "The continuity and the connectivity of space owes its existence to quantum-mechanical entanglement." Entanglement, then, may undergird the structure of space itself, forming the warp and weft that give rise to the geometry of the world.[1481]

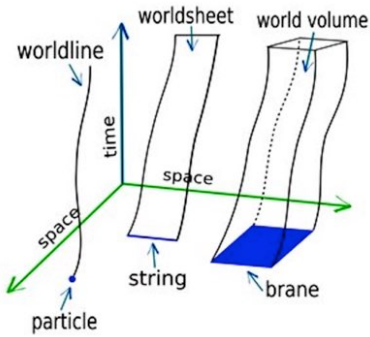
But spacetime means space is time and time is space according to general relativity. It seems that time only exists as a classical fall

into narrative, certain dominant histories arising from the observer effect. But the observer effect is not emergent in some fashion from our historic narratives but as “the characteristic trait of quantum mechanics” with spooky entanglement. However, entanglement is not causal, not subject to cause and effect. Time is an abstract classical concept which relates cause to effect. Time is conceived as a necessary condition for cause and effect. Only in the collapse of the wavefunction do we have a sequence of states, a spooky temporality where observation recursively reverberates, branches off as narrations of temporal informational updating.

As mentioned earlier, loop quantum gravity gives us an interesting theory about how spacetime might emerge from entangled quanta. Worldlines and world sheets are concepts in string theory. In string theory, the fundamental objects are not point particles but strings. A worldline is the path traced out by a single string as it moves through spacetime. A worldsheet is the two-dimensional surface swept out by a string as it moves through spacetime. In string theory, the transition from worldlines to world sheets occurs when we generalize point particles to strings. The sum over topologically trivial world-sheets gives classical, or free (i.e. leading order in $\hbar$) string theory, and quantum corrections (or interactions) come from including world-sheets of more complicated topology.

Recall that worldlines are made up of particles connected into nodes. The nodes themselves have no direction of time. Spin networks of spin nodes define a three-dimensional hypersurface or curved surface of space. Nodes and links can be added and subtracted like soap bubbles. The network dynamism is called spin foam. The change of spin foam is the emergence of one-dimensional time. Together, the three-dimensional hypersurfaces of spin networks and one-dimensional spin foam changes make up four-dimensional spacetime. Loop quantum gravity makes a theoretical attempt to be compatible with Einstein’s general relativity. However, instead of Einstein’s smooth, continuous transitions of

spacetime, loop quantum gravity is composed of chunky, discrete particles. Yet again, we see complementarity of wave and particle. Worldsheets are a result of spin foam from worldlines in loop quantum gravity.[1482] World lines, worldsheets, and world volumes, are derived from particles, strings, and branes as shown below.



[1483]

Spin foam is a model of quantum spacetime that describes the quantum geometry of space and spacetime. It is a generalized Feynman diagram where instead of a graph, a higher-dimensional complex is used. The existence of a semi-classical limit, in which classical space-time and the Einstein field equations are supposed to emerge, is widely regarded as the main open problem of the loop quantum gravity approach. [1484]

> It seems all but certain that the observable history of our universe began about fourteen billion years ago at a point in the Landscape with enough energy density to inflate our patch of space by at least 1020 times. That is probably an enormous underestimate. The energy density during this period was very large—how large we don't know for sure but vastly larger than anything we can make in the laboratory, even during the most violent collisions of elementary particles in the largest accelerators. It appears that at that

time, the universe was not quite trapped in a valley of the Landscape but was resting on a slightly tilted plateau. As it inflated, our pocket of space (the observable universe) slowly rolled down the shallow tilt, toward a sudden, steep ledge, and when it got to the edge of the ledge, it quickly descended, converting potential energy to heat and particles. This event, which created the material of the universe, is called reheating. Finally, the universe rolled down to our present valley, with its tiny anthropic cosmological constant. That's it: cosmology as we know it was a brief roll from one value of the vacuum energy to another. All the interesting things happened during this transitory period.

How did our pocket universe get up on the ledge? That's what we don't know. But it is mighty convenient that it started where it did. Without the Inflation caused by the energy density on the ledge, the universe could not have evolved to the large, matter-filled universe we see around us: a universe big enough, smooth enough, and with density contrasts just right for our own existence.

The problem with a theory that places us on the ledge at the very beginning is that this is just one of a stupendous number of starting points. Its only distinction is that it provides a potentially successful beginning for a universe with a chance for life to evolve. Arbitrarily placing the universe at such a lucky spot on the Landscape would defeat the goal of explaining the world without an intelligent designer. But as I will explain, a theory with an enormous Landscape has no choice. To my mind it is completely inevitable—mathematically certain—that some parts of space will evolve to find themselves at the lucky spot. 1485

The vacuum has the quantum jitters. Just like the thermal jitters of supercooled water, the quantum jitters cause small bubbles to form and disappear. The interior of these bubbles may lie in a neighboring valley, with smaller altitude. This

bubbling is constantly going on, but most of the bubbles are too small to grow. The surface tension on the domain walls separating the bubble from the rest of the vacuum squeezes them away. But, as in the supersaturated case, every now and then a bubble forms that is big enough to start growing.

The mathematics describing this bubble formation in an inflating universe has been known for many years. In 1977 Sidney Coleman and Frank De Luccia wrote a paper that was to become a classic. In their paper they calculated the rate at which such bubbles would appear in an inflating universe, and although the rate could be very small—very few bubbles per unit volume—it most certainly is not zero. The calculations used only the most trustworthy, well-tested methods of quantum field theory and are considered by modern physicists to be rock solid. Thus, unless there is something terribly wrong, the inflating vacuum will spin off growing bubbles located in neighboring valleys.

Do bubbles collide, eventually coalescing so that all of space winds up in some new valley? Or does the space between the bubbles expand too quickly to allow the islands to merge? The answer depends on the competition between two rates—the rate of bubble formation and the rate that space reproduces, or the rate of cloning. If the bubbles form very quickly, they will rapidly collide and merge, the whole space moving to some new point on the Landscape. But if the rate at which space reproduces is greater than the rate at which bubbles form, cloning wins, and the bubbles never catch up with one another. Like the islands of ice in the inflating supercooled lake, the bubbles evolve in isolation, eventually moving beyond one another's horizons. The majority of space continues to eternally inflate.

Which wins, bubble nucleation or space cloning? Generally the answer is not even close. Bubble nucleation, like all other tunneling processes, is rare and improbable.

> Typically, a very long time will elapse before a bubble large enough to expand accidentally nucleates. On the other hand, the cloning of space, i.e., the exponential growth due to vacuum energy, is extremely rapid if the cosmological constant is not ridiculously small. In all but the most contrived examples, space continues to clone itself exponentially, while islands or bubbles slowly nucleate in neighboring valleys of the Landscape. By a very wide margin, the cloning of space wins the competition.
>
> Let's take a look inside one of the bubbles. What do we find? Typically we will find ourselves located in a valley with altitude somewhat lower than at the start. Space inside the bubble will also be inflating. I'm not speaking about the ordinary growth of the bubble but about the cloning of space inside the bubble. Thus, we start over again. A new patch of space is now located in a new valley. But there are still other, lower valleys. Inside the original bubble, a next-generation bubble may form in another nearby valley with a lower altitude. And if that bubble is bigger than critical size, it begins to grow—a growing bubble inside another bubble. 1486

I will get into this more later in the section entitled, "Lived Space and Time" where Susskind describes the dynamics between:

1) how spin foam bubbles which clones spacetime growing at a certain rate in certain 'landscapes' (which are really regions of spacetime which can have various 'laws of physics') and

2) the expanding universe.

If the bubble cloning of spacetime grows faster than the universe expands major transitions like what happened in our cosmological inflation period, it can drastically change even the 'laws of physics' and the 'landscapes' dramatically. This is like vast potential energy changes quickly. On the other hand, if the universe expands faster in a landscape than spacetime bubble cloning new degrees of

freedom are added increasing the complexity of the universe.

In the two-dimensional diagram of the spin network above time flows in one direction. For instance, from bottom to top of the diagram[1487] causality is conserved in loop quantum gravity. Effectively, gravity, the curvature of spacetime in spin foam, makes up the evolving block universe of worldlines. As I will discuss later, the glue that holds spacetime together is composed of spin foam which is highly entangled particles.

Pardon my indulgences here but could we call the density of entangled systems which might evolve from loop quantum gravity into spacetime as a kind of lived spatiality and temporality which feels more like how we experience time and space phenomenologically? Quantum entanglement does not stop at or account for classicisms abstract notions of spatiality as linear extension and temporality as a succession of 'now' moments stretching from a past to a future. The density of entangled systems is non-local in the sense of linear distance. If the quantum wave function is what it purports it must include our lived experiences, feelings, loves, desires, hatred, anger, and sense of self. When we feel closer to someone, when we love them, could it be that our entangled systems become denser. When we hate someone, could wavefunction collapse, always altering from observation reduce entangled systems giving us the lived feeling of distance? Do entangled systems as density translate to mass, inertial resistance to change in motion, curved spacetime on the largest and smallest scales? Is there an analogous way to think about the attraction of gravity in terms of entangled systems? Could entangled systems translate to love in terms of closeness, hate in terms of distance and alienation…emotive effects analogous to gravity which attract and coalesce? Does state reduction of the quantum wave function have effects to quantum tales we weave which take leave of proper quantum physics? Who is to say that exformation as aesthetics may bring us closer to profundity, to wonder, to externality, in the gap which can never attain certainty, can never find cause? Was Kant's

notion of *a priori* categories of understanding was rather an intuition of exformation rather than an apodictic certainty? It seems to me that we cannot reserve far reaching 'affects' from effects if we are to take the intended reach of the quantum wave function seriously. Otherwise, we would have to fall back on the same metaphysics which have forced us to maintain traditional paths of ontology and epistemology which have exhausted themselves in our histories of wars and violence and have left us exasperated to try to yet once again resurrect them through sheer reactionary willpower, to 'will it thus'. All the while nuclear and environmental annihilation on this planet draws uncomfortably closer.

Is the Limit of Classical Chaos Found in Quantum Chaos?

Just as classical physics is a limit which can be explained from relativity, and perhaps relativity can find its limit in quantum field theory, can classical chaos theory be explained from quantum chaos theory? There is a branch of quantum chaos theory which wants to do just that. It studies how chaotic classical dynamical systems can be described in terms of quantum theory. The primary question that this field of quantum chaos seeks to answer is: "What is the relationship between quantum mechanics and classical chaos?"[1488] The correspondence principle states that classical mechanics is the classical limit of quantum mechanics, specifically in the limit as the ratio of Planck's constant to the action of the system tends to zero. If this is true, then there must be quantum mechanisms underlying classical chaos (although this may not be a fruitful way of examining classical chaos). Several approaches have been employed to address this question, including development of methods for solving quantum problems where the perturbation cannot be considered small in perturbation theory and where quantum numbers are large, correlating statistical descriptions of eigenvalues (energy levels) with the classical behavior of the same Hamiltonian (system), study of probability distribution of individual

eigenstates (see scars and Quantum ergodicity), semiclassical methods such as periodic-orbit theory connecting the classical trajectories of the dynamical system with quantum features, and direct application of the correspondence principle. 1489

As I mentioned earlier, classical chaos theory is based on the idea that initial conditions can be infinitesimally more accurate. The butterfly effect refers to the idea that small changes in initial conditions can lead to vastly different outcomes in a chaotic system. However, these vastly different outcomes are determined from initial conditions. Classical chaos theory still maintains causal relations which stem from initial conditions. However, it does maintain that vastly different outcomes such as a butterfly flapping its wings in Texas can cause a tornado in Brazil. Effectively, the classical notion of chaos still maintains symmetry in the universe which is infinite and infinitesimal albeit quite bizarre in its effects. However, the quantum chaos theory reaches a limit that classical chaos theory cannot breach. Quantum chaos theory has proven that the quantum version of the butterfly effect gets increasingly weaker until initial conditions no longer influence classical chaos outcomes. Quantum chaos has several broad transitional stages which move from environmentally highly isolated experiments such as with pure quantum states and mixed states, called strong measurements, to partial environmental immersion called ‘quantum baths’, called weak measurements, to more normal quantum wave function environmental conditions which are fully chaotic and exhibit no order at all, called pure chaos. Additionally, quantum chaos in the wave function is informational only meaning it has no physical attributes we think of as heat, entropy, thermodynamics, etc. However, recent studies have shown that pure quantum chaos in the wave function gives our classical universe heat upon state reduction. 1490 This is the environment we live and move and have our being in which classicism and state reduction reign supreme as ‘commonsense’. 1491

There is an interesting footnote to this. Recent investigations

have found that under certain experimentally contrived conditions quantum chaos can be introduced into a coherent, entangled system, which can actually increase coherence time before falling into complete decoherence. Perhaps this can be semiclassically or analogously thought of as a kind of Shannon noise channel. If so, it might indicate that tightly controlled levels of quantum chaos may suppress certain conditions that accelerate decoherence as in state reduction of the quantum wave function. Another way to think about this is that pure quantum chaos is not the exclusion of order in favor of disorder as much as an alterity to the binary dualism of order and disorder. This also exhibits the very odd, hazy in-between of pure quantum chaos.[1492]

Earlier I mentioned "There is no practical way of reversing the result, the branching of the quantum wave function. But narration accommodates abstractions such as narrations of going backwards and thus unitarity." I speculate that within certain boundaries, expansions of complexity accommodate limited case scenarios. For example, given certain assumptions classical notions of absolute space and time can suffice as a limited case of wave function branching. That is at least for our universe, laws of physics, spacetime narrations. This might also be thought of as semiclassical (analogical, or dare we think macro-narratives?) Perhaps limited case scenarios might also provide some kind of radically contingent basis for historic narratives of metaphysics of essence, Being, absolute, etc. As we will see later Levinas has perhaps an interesting correlation of the "third other" forming the basis for justice and *logos* (e.g., narratives) as historically conceived. But this is jumping too far ahead for now.

Philosophical Reflections on Information, Entropy, and Vacuum Energy

All information gurgles forth from the quantum foam of the haze of virtual particles which are "occurring all over space-time, filling it with a rapidly fluctuating population of elementary particles. These

short-lived quantum particles that fill the vacuum are called virtual particles,[1493] but their effects can be quite real. Vacuum energy comes from these virtual particles. The vacuum is not the state of zero energy. It is merely a state of minimum energy." (Susskind, 2008, p. 73) Perhaps this kind of information can be thought of as all information given at once, without form, the gaping void. One way this is thought of in physics is as the term - entropy. The second law of thermodynamics tells us that all systems move towards entropy. It seems that from within our ever-expanding spacetime bubble we are ever moving towards rising entropy. We call this the heat death of the universe.

As mentioned, the second law of thermodynamics tells us that all systems tend towards entropy. In information theory, the entropy of a random variable is the average level of "information", "surprise", or "uncertainty" inherent to the variable's possible outcomes. The relation between information and entropy is mathematically encapsulated in the uncertainty of quantum physics. This uncertainty is not due to a lack of information but rather due to the potential of what can show itself phenomenologically. Information shows itself phenomenologically in quanta, reciprocally in entropy as the amount of uncertainty. The uncertainty of quantum information is not due to some kind of lack or vacuum of information. As we saw with Heisenberg's uncertainty principle, uncertainty is not some kind of ignorance about underlying order. There is no underlying order.

Entropy is information which has no order. In quantum entropy, we see this in exformation which knows nothing of spacetime, of cause and effect. Exformation knows nothing of an underlying 'reality' which exists when we are not looking at it. Remember that 'not looking at it' is not some purely reducible subjective psychic form. With that said, existence and reality more properly show themselves as notions arising out of a history of metaphysics, of a classically defined cause arising from our lived phenomenological 'being in the world'. Our ways of 'being in the world' typically get

taken up in the West as Being itself. In this sense 'Being' gets taken up in a culture, language, and history which finds itself in the face of my 'there of being' [*dasein*].

Dasein is a fundamental concept in the phenomenology of Heidegger referring to the experience of being that is particular to human beings. The term *Dasein* (sometimes spelled as da-sein) comes from the German word for "existence". It signifies more than mere existence; it encompasses the awareness of issues such as personhood, mortality, and the paradox of living in relationship with others while ultimately being alone with oneself. Heidegger's use of *Dasein* emphasizes the following aspects:

- Being-in-the-world: Heidegger uses *Dasein* to emphasize that human existence is inherently intertwined with the world. It is not merely consciousness or abstract subjectivity but rather practical engagement with one's environment.
- Awareness of Mortality: *Dasein* confronts existential issues such as personhood, mortality, and the paradox of living in relationship with others while ultimately being alone with oneself.
- Authenticity vs. Inauthenticity: Heidegger distinguishes between authentic and inauthentic *Dasein*. Authenticity involves facing one's individuality, limited lifespan, and truth, while inauthenticity involves immersion in the anonymous, identical world of societal norms and collective existence.
- Uncovering and Disclosure: *Dasein* uncovers and discloses other entities as well as itself. It is a mode of existence that reveals the contingent nature of involvement with the world. 1494

Being (with a capital B) is a concept of singular importance in Heidegger's philosophy. Heidegger differentiates between Being

(capitalized) and being (lowercase). The capital B signifies a contrast with individual beings (lowercase), which refer to specific entities or things. Being is not a proper name like “God”; it encompasses the quality shared by all beings. Heidegger’s work is rooted in the phenomenological tradition influenced by Edmund Husserl. Phenomenology aims to explore things in themselves, beyond our subjective faculties. Husserl’s famous phenomenological slogan is “back to the things themselves,” emphasizing direct engagement with existence.

In the introduction to Heidegger’s early and famous work entitled, “Being and Time” Heidegger tells us,

> 1. First, it has been maintained that ‘Being’ is the ‘most universal’ concept: τὸ ὂν ἑστι καθόλου μάλιστα πάντων.(i) Illud quod primo cadit sub apprehensione est ens, cuius intellectus includitur in omnibus, quaecumque quis apprehendit. ‘An understanding of Being is already included in conceiving anything which one apprehends in entities.’(1) (ii) But the ‘universality’ of ‘Being’ is not that of a class or genus. The term ‘Being’ does not define that realm of entities which is uppermost when these are Articulated conceptually according to genus and species: οὔτε τὸ ὂν γένος.(iii) The ‘universality’ of Being ‘transcends’ any universality of genus.
>
> 2. It has been maintained secondly that the concept of ‘Being’ is indefinable. This is deduced from its supreme universality,(iv) and rightly so, if definitio fit per genus proximum et differentiam specificam. ‘Being’ cannot indeed be conceived as an entity; enti non additur aliqua natura: nor can it acquire such a character as to have the term “entity” applied to it. “Being” cannot be derived from higher concepts by definition, nor can it be presented through lower ones. But does this imply that ‘Being’ no longer offers a problem? Not at all. We can infer only that ‘Being’ cannot have the character of an entity. Thus we cannot apply to Being the

concept of ‘definition’ as presented in traditional logic, which itself has its foundations in ancient ontology and which, within certain limits, provides a justifiable way of characterizing “entities”. The indefinability of Being does not eliminate the question of its meaning; it demands that we look that question in the face.

3. Thirdly, it is held that ‘Being’ is of all concepts the one that is self-evident. Whenever one cognizes anything or makes an assertion, whenever one comports oneself towards entities, even towards oneself,(1) some use is made of ‘Being’; and this expression is held to be intelligible ‘without further ado’, just as everyone understands ‘The sky is blue’, ‘I am merry’, and the like. But here we have an average kind of intelligibility, which merely demonstrates that this is unintelligible. It makes manifest that in any way of comporting oneself towards entities as entities—even in any Being towards entities as entities—there lies a priori an enigma.(2) The very fact that we already live in an understanding of Being and that the meaning of Being is still veiled in darkness proves that it is necessary in principle to raise this question again. 1495

Being (capital B) represents what gets covered over in everydayness by beings (individual being-theres). There are two modes for *Dasein*’s being-in-the-world: authentic and inauthentic. Both modes of existing already have a pre-understanding of Being (capital ‘B’). I have indicated this previously in the book when I referred to all the forms of the verb ‘to be’ (is, was, are, etc.) as simple concepts which have covered over, taking for granted and simply assumed, as already understood in everyday language. When beings are inauthentic, the question of Being gets covered over by the they-self of everydayness which Heidegger refers to a *das man* (they self). When beings exist in the mode of authenticity the question of Being is allowed to surface from its presuppositions into

a resolute intention to uncover and disclose what Being could possibly mean.

> Dasein always understands itself in terms of its existence—in terms of a possibility of itself: to be itself or not itself. Dasein has either chosen these possibilities itself, or got itself into them, or grown up in them already. Only the particular Dasein decides its existence, whether it does so by taking hold or by neglecting. The question of existence never gets straightened out except through existing itself…
>
> So far as existence is the determining character of Dasein, the ontological [Being] analytic of this entity always requires that existentiality be considered beforehand. By "existentiality" we understand the state of Being that is constitutive for those entities that exist. But in the idea of such a constitutive state of Being, the idea of Being is already included. And thus even the possibility of carrying through the analytic of Dasein [the there of being] depends on working out beforehand the question about the meaning of Being in general…
>
> If to Interpret the meaning of Being becomes our task, Dasein is not only the primary entity to be interrogated; it is also that entity which already comports itself in its Being, towards what we are asking about when we ask this question. But in that case the question of Being is nothing other than the radicalization of an essential tendency-of-Being which belongs to Dasein itself—the pre-ontological understanding of Being. 1496

The pre-ontological understanding of Being is not the *a priori* of Kant's categories of understanding but the phenomenal, lived experience we already know in naming Being anonymously in everydayness. 1497 But phenomenology, our lived experience, is not subjugated to the abstractions of clock time and linear distance, the

heroes of classical physics. Neither is lived experience subjugated to some kind of totality of 'my' lived experience which is fundamentally severed from the sense of 'our' lived experiences. Lived experience is drawn from particular histories of self and others, language and culture, branching from the quantum wave function. My being (ontic) and Being (ontological) all fall together with the state reduction of the observer effect. But since state reduction implies decoherence, information about all the other branches is forever lost. The self 'is' my incessantly branching of state reduction. But exformation in the wave function is excessively exterior to 'self'.

Classical Information is the state reduction of the wave function and exformation. The wave function certainly would include the sum total of all actual and potential knowledge. Information has been classically derived from observation including scientific and phenomenologically. These derivations as knowledge are actually restrictions or reductions of all possible [potential in Aristotle] information. As an analogy let's take how we see through a colored optical lens. It seems to us that the optical lens adds color to what we see from colorless sunlight. However, what really happens is that the lens filters out all the other colors of colorless sunlight, so we only see the colors which are allowed to pass through the lens. Likewise, all knowledge at various levels from common-sense to quantum physics to biology to anthropology, etc. do not address all possibilities. These kinds of scientific inquiries must necessarily arise from state reduction in order to make observations about their proper fields of interest, domains. More properly, these fields of interest must restrict all potential information in order to 'be', to make judgements within their perspective disciplines. There never is an 'absolute knowledge' as if some particular knowledge could finally rid itself of contingency. Some have thought of this as levels of description.

The idea of 'levels of description' seems to find a solace, a passivity in facing the void which faces us, which might more

properly be thought of as suspension of what is deemed as extraneous. Metaphorically, these levels of description are islands in our 'lived vacuum ocean'. In physics, branes and strings in the vacuum ocean may well go beyond the Big Bang's expanding event horizon which, for one thing, is incapable of capturing the light that can never reach us. From an informational point of view, there is no origin of knowledge which makes one area of knowledge rule authoritatively over other areas of knowledge. In physics now we have bumped into a vast excess which has the capacity to show us an 'other' which has not been taken up by our histories. The face of anarchy, without origin, has long been encapsulated in physics as entropy. The measure of entropy is the measure of chaos in a system.

In classical thermodynamics, the degree of disorder of a system is referred to as entropy. The second law of thermodynamics tells us that every classical system tends toward disorder. This implies that there is a relationship which can be quantified between all possible classical information and the classical information of a particular ordered system. In 1948 a physicist named Claude Shannon published a paper named "A Mathematical Theory of Communication". The paper mathematically tells us that every classical communication channel has a degree of noise. This noise can be characterized mathematically to tell us the maximum amount of useful information which can be transmitted in this channel. This is an astounding theory which in other terms tells us the classical background information of entropy in the system has a reciprocal relationship to what we can learn from the system.

Virtual particles are the vacuum energy of the universe. Virtual particles are the froth of particles popping in and out of existence. Virtual particles are well established to exist at random times as we previously discussed. However, they are magnitudes of orders below what we will likely ever be able to see directly because they exist closer to Planck levels like the graviton. The universe can be seen as an informational channel. This means virtual particles are

the Shannon noise of the universe. The Shannon noise of the universe is entropy. It has a kind of negative relationship to what we know. This implies that disorder in approximating the amount of classical chaos in a system becomes a quantifiable relationship to order - the lens which determines which colors we see. We see reality because of what we do not see, what we cannot see. This is not what dominant, historic and religious narratives have led us to believe. Religious mythologies inform us we have fallen from the garden, from God, and cannot directly see 'reality'.

Hegel believed that the Concept is a complex and abstract idea that is difficult to comprehend. According to Hegel, the Concept is not a static or fixed idea, but rather a dynamic and evolving one that is constantly changing and developing. He believed that human consciousness is shaped by our experiences and interactions with the world around us. Hegel also believed that the Concept is not something that can be easily grasped or understood, but rather something that requires a great deal of effort and reflection to fully comprehend. Some Hegelians would argue that due to the failure of Hegel's attempt in the "Phenomenology of Spirit" to arrive at Concept, consciousness may not be able to fully grasp Concept, but Concept can realize itself. But all our struggles are really Concept having forgotten itself. However, through the dialectic, Concept finally and absolutely realizes itself. This might remind us in some ways of how we have seen the quantum wave function works.

The problem with religious myths is that there is an absolute God which stands above or in existence and offers some hope of reconciliation to fallen humans. The problem with Hegel's Concept is that it is the final and absolute self-realization of itself (at least until it decides to forget itself again which begins space, time, and everything else all over again). In any case, Concept can be fully comprehended and recognize itself. If the quantum wave function has a corollary to religious mythologies and Hegel's Concept it would be the mythical La Place's demon. However, as I pointed out before, La Place's demon would have to simultaneously already

have been taken up together with and in the quantum wave function which would incessantly tie one more simultaneous knot in the attempt to untie the Gordian knot as absolute knowledge and order. So, even La Place's demon is a nice little myth we tell ourselves but would only contribute to chaos, not stand apart from chaos with a God's eye view. Therefore, the real difference in religious and Hegelian myths is that they find completion and fulfillment even if temporarily in absolute understanding and knowledge. The fall away from Godhood or Absolute Concept into classicism is necessary not because of Eve's misogynist sin or the failure of consciousness, the reverberating his-story of Being or absolute Concept. Both narratives assume a divine or evolved self-realized absolute Concept. The quantum wave function is chaos, lack of origin, with the spooky observer effect. It is extreme externality which cannot be subsumed in some metaphysics or pretention towards absolute knowledge or order. This is why I like the rhizome metaphor of growth in mythologies of the tree of life.

From Gates and Algorithms to Quantum Field Theory, Complexity Theory, Chaos Theory, and...

The event horizon of a blackhole and the universe are very large. Singularities and virtual particles are very small. Many dimensions can be compacted into our four-dimensional spacetime which could explain how the curvature of our spacetime we call gravity has a much weaker effect than the other three forces of electromagnetic, strong, and weak nuclear forces in a small distance but could have a huge effect on a planetary scale. Let's look once again at the mathematical geometry partially developed to understand blackholes to see how the very large and the very large can play together with the very small.

The holographic principle emerges from string theories and quantum gravity. It posits that the description of a volume of space can be encoded on a lower-dimensional boundary to that region.

This idea was inspired by blackhole thermodynamics and the need to reconcile the information paradox associated with black holes. The holographic principle gained prominence through the AdS/CFT correspondence, proposed by Gerard 't Hooft and further developed by Leonard Susskind. According to this correspondence, the entanglement entropy in a boundary theory is related to areas of minimal surfaces in the Conformal Field Theory (CFT) to what we perceive as volume in anti-de Sitter (AdS) space. Specifically, the Ryu-Takayanagi proposal suggests that the entanglement entropy is connected to minimal surfaces that extend into the bulk AdS space. Think about it like this, our three-dimensional universe—filled with galaxies, stars, planets, and everything else—is akin to a hologram, an image of reality projected from a highly encoded two-dimensional surface which would be akin to an event horizon for the entire universe or better the observable universe, visible universe, causal universe, particle universe, or conformal limit of the universe.

This comes back to the cosmological idea of the Big Bang and its 'singularity'. Inside the universe, the Big Bang blackhole has a singularity. Remember there is no volume or spacetime 'outside' the moment (which does not exist) of the singularity. At the present time we think that we are 'really' outside the singularity, emerging out from the Big Bang singularity. But 'out' and 'in' are meaningless terms for entangled AdS/CFT correspondence. Perhaps the way to think about this is that our 'out' as spacetime is really the inside of the cosmic Big Bang blackhole we are actually still 'in'. Our 'in' is the event horizon of the cosmic Big Bang blackhole, what we visualize as the 'edge' of the universe but is really the observable universe, visible universe, causal universe, particle universe, or conformal limit of the universe. It turns out that in our universal rabbit hole out is in and in is out.

The surface area of the 2-D boundary of a blackhole described by CFT mathematics can be thought of as a minimal surface corresponding to the entangled degrees of freedom in the boundary

theory. However, there's a catch: the minimal surfaces cannot probe the entire geometry behind the black hole horizon. The horizon acts as a barrier, preventing us from fully understanding spacetime in terms of entanglement. This barrier, the event horizon, does not let us peer into the bowels of its volume, the universe of space. What we can only 'see' from the outside looking at a blackhole is not spacetime as that no longer exists. What we see as darkness is facsimile, encoded exformation which finds its limit in chaos.

While quantum entropy as a measure of information we do not know or have access to about entangled systems in the wave function provides valuable insights, it may not be sufficient to explain the full story. Enter quantum complexity. Quantum complexity measures the minimum number of unitary transformations required to construct a target state from a given reference state. In other words, it quantifies how complex it would be to evolve from one state to another. Unlike entanglement, which focuses on correlations between subsystems, quantum complexity considers the intricate dynamics of the entire system. The holographic principle suggests that spacetime itself emerges from the collective complexity of entangled degrees of freedom. Black holes pose a challenge because their event horizons obscure our view of the interior. The holographic principle proposes that the information content of all objects that have fallen into a black hole might be entirely encoded in surface fluctuations of the event horizon. In other words, the black hole's surface (the event horizon) contains a condensed representation of everything that has entered it. This surface information encodes the underlying spacetime geometry. The holographic principle resolves the black hole information paradox within the mathematical framework of string theories. The holographic principle intertwines entanglement, minimal surfaces, and quantum complexity to unveil the profound connection between gravity, information, and emergent spacetime.

Blackholes drag spacetime itself into their event horizon. If all the spacetime surrounding our planet earth were dragged into a

huge blackhole we would not see or feel anything different because our entire relative frame would be dragged in wholly as if nothing had happened. This is called frame dragging. But as the earth fell in virtual particles from zero-point energy or vacuum energy would spontaneously pop into existence and become entangled with our spacetime frame. Half of the entangled particles would go into the blackhole, and the other half would go out into our universe as Hawking radiation. [1498] One particle of the pair falls into the black hole, while the other escapes outward. One particle falls into the black hole, while its entangled partner escapes as radiation. Hawking's calculations showed that the emitted radiation is quantum mechanically entangled with the black hole itself. [1499] This escape from the blackhole creates the appearance of radiation emanating from the black hole. Could Hawking radiation contribute to dark matter? A 2021 study proposed that Hawking evaporation generates particles democratically, producing all particle species regardless of their charges or couplings. This includes neutrinos and potentially dark matter particles. [1500] This process will gradually result in the black hole to start losing mass. At this point in the discussion, it is better to lose our classical notions of inside and outside. Notions we have of spacetime being dragged inside towards a singularity or something and Hawking radiation matriculating outside obfuscate what is really happening. Why?

In an issue of Scientific American there is an article entitled, "How the Inside of a Black Hole Is Secretly on the Outside" [1501] The exformation of entangled particles going inside the blackhole slip into the blackhole cogently as if nothing ever happened due to frame dragging already mentioned. However, the Hawking radiation emitted back into our spacetime seems truly random. Seemingly, there is no unity, higher concept, fundamental law of physics which would allow us to put Humpty Dumpty back together again. This is chaos. We call this entangled entropy. But there is a problem with this – the conservation of information.

The conservation of information is a fundamental concept in

physics, particularly in the realm of quantum mechanics. The no-hiding theorem states that if information is lost from a system due to decoherence (interaction with the environment), it moves to the subspace of the environment rather than being completely lost. This theorem is a consequence of the linearity and unitarity of quantum mechanics. In other words, information is never truly lost; it simply shifts into the environment. The no-hiding theorem has implications for phenomena like the black hole information paradox and any process that seems to lose information completely. In 2011, this theorem was experimentally tested using nuclear magnetic resonance devices, demonstrating the conservation of quantum information.

In physics, conservation laws play crucial roles. For instance, the law of conservation of energy states that the energy of a closed system remains constant. Similarly, in the quantum world, the conservation of quantum information means that information cannot be created nor destroyed. This concept arises from two fundamental theorems: the no-cloning theorem and the no-deleting theorem. Quantum mechanics allows only one way to completely hide an arbitrary quantum state from one of its subsystems: by moving it to other subsystems. The conservation of information ensures that quantum information persists, even when it seems to vanish or transform. 1502

Information can be chaotically jumbled up, dramatically altered, and be purely chaotic while at the same time preserving all of its information. Chaos does not mean either order or disorder. It means both-and, and also an excess, a radical excess. So, we again call this complementarity. So, how would this apply to Humpty Dumpty?

What if the exformation falling into the blackhole did not get crunched into nothingness, *ex nihilo*, but actually found its way into another quantum branch via a wormhole? As this book has demonstrated, exformation is vastly different from our conventional notion of locality, of space and time. The unseen undergirding locality is the far spookier excess to ‘reality’ which permeates

infinite branches of possibilities simultaneously. So, how can information going into a blackhole avoid being lost forever? One answer was the page curve which tells us at some point all the information that went into the blackhole will matriculate out in Hawking radiation over vast periods of time. In effect, the blackhole would evaporate. This evaporation process starts to happen at the apex of the page curve. However, there is another far spookier idea that due to entanglement, all the information which falls into a blackhole simultaneously falls out of the blackhole. So, the inside is the outside and the outside is the inside.

In the wave function's entanglement operator this kind of non-local information is handled mathematically requiring renormalization in order to compare apples to apples and oranges to oranges. More specifically, the square of the wave function ends up being a number other than infinity. This is the telltale sign that a probability exists but the 'somewhere' does not make sense. Entanglement replicates itself which enables it to conserve information exformationally. Remember that 'quantum entropy' is a semiclassical notion based on our conventional ideas of entropy but without any materiality such as heat, energy, thermodynamic equilibrium which have a purely classical 'reality'. Quantum entropy in the wave function is from the loss of entangled information. It is exformation "Lost in Space" (for those old enough to remember that show). If spacetime itself is falling into the blackhole it meets an island, a white hole in a sense, which is really external to the blackhole. Rather than try to conserve our historic notions of 'outside' and 'inside' quantum physics just tells us these ideas obfuscate more than they make clear so that commonsense 'voice of reason' needs to take a hiatus. Here is a more detailed explanation for what some physicists believe is happening.

In a Scientific American article entitled "How the Inside of a Black Hole Is Secretly on the Outside" [1503] the author asks, "Why does it matter if some blackholes are connected by wormholes?" He goes on to explain it matters because it preserves information going

into the blackhole. A key and fundamental concept in physics is that information cannot be lost. Information can migrate, change, make copies, and do lots of things but it cannot be lost. Even entropy is not lost information. It is more complex information. Here is how this works.

When entangled spacetime itself passes the event horizon of a blackhole, part of the entangled information comes out of the blackhole as Hawking radiation. The information coming out of the blackhole is highly encoded information. This information is much more complex and as such has more *entropy*. The encoded Hawking radiation is a copy of what passed beyond the event horizon.

There is something called a replica trick in physics. The replica trick tells us that the inside of the blackhole is really on the outside of the blackhole. The interior of the blackhole gets swapped with the interior of a blackhole which is on the outside. Note that *outside* may or may not have anything to do with our universe or universes in general. Everything in one blackhole is swapped with everything in the other blackhole. So, what is inside our original blackhole is what was originally inside another blackhole. Spacetime itself inside the blackhole gets swapped out irrespective of time and space. We have traditionally called this a wormhole. Physicists call these blackhole interiors *islands*. Islands encompass almost all the interior of the blackhole. The swapped-out interiors also take the Hawking radiation emitted from the blackhole. In a technical sense, there is no entanglement between the interior of the blackhole and the Hawking radiation since it all goes together to the *exterior* or *outside* blackhole and vice versa. Why does this solve the problem?

When the Hawking radiation and the previously thought entangled interior of the blackhole are separated without the replica trick there is an unaccounted-for entangled entropy. Recall entropy is really more complex information. If the math does not add up, then information is lost and so is just about everything else in quantum physics. We would have to start all over from scratch and who wants to do that? Well, since in the replica trick there is

no entangled entropy (e.g., Hawking radiation and island) because there is no entanglement - that problem simply vanishes!

And, to put a cherry on top that piece of ice cream another math works out beautifully. Remember the discussion about how the one less dimensional, surface, event horizon is an encoded copy of the one dimensional higher, volume, of the interior of the blackhole? We called that the holographic principle. It comes almost complete with the AdS/CFT (anti-de Sitter/ conformal field theory) math. Well, it turns out that the remaining entangled entropy to be accounted for and "*comes almost entirely from the probability of the swap actually occurring, which is equal to the area of the boundary of the island—roughly the area of the event horizon—divided by Newton's gravitational constant*". So, it agrees with the holographic principle! (I know you are excited now – admit it).

Hawking believed that initially Hawking radiation would increase and eons later it would reach a mid-point where it would start to decrease. Eventually, the blackhole would just dissipate like a whirlpool in the water. The curve that describes this is a very famous mathematical curve call the Page curve. [1504] Remember the argument Susskind and Hawking had for a decade? Ok, if you are not a nerd, this should make you one. When the blackhole shrinks its contribution to entropy decreases. And, presto, this becomes the island formula, replica trick, accounting for the entangled entropy of Hawking radiation. So now there is still a minimum entropy between the island formula and Hawkings original calculation. This agrees with the Page curve. Hawking's original formula starts off smaller than the area of the event horizon of the black hole. However, as the area shrinks the new island formula becomes predominant and agrees with Hawkings radiation entanglement entropy. All that to say that much of the history which was disjointed now comes together in beautiful harmony and agreement. Physicists love it when this type of thing occurs. Now come on, how could you not love this - really? As a side note, some folks at LSU have devised a way to demonstrate the quantum origin

of Hawking radiation. [1505]

As I tried to elucidate in the holographic principle, the two-dimensional event horizon of the blackhole is the boundary condition for the three-dimensional volume of the blackhole. Actually, in string theory this principle can apply to any number of dimensions where the lower dimension encodes all the information of one higher dimension. This basic idea can explain the behavior of what we call 'point particles' in the "Standard Model of Particle Physics". [1506] When we combine the holographic model of quantum gravity with the blackhole interior where the inside island is outside, we begin to get a better sense of the quantum wave function which is an incalculable excess to all our classical, conventional options solidified in what we simply think as commonsense. [1507]

This also spills over into tiny wormholes – the idea that our metaphorical 'three-dimensional' homogenization into spatial 'commonsense' has a lower boundary or dimension which encodes not only spacetime itself but every entangled system in spacetime with 'hyper-Swiss cheese' wormholes is mind boggling. Think about this, every inside the wormhole of an entangled particle or system is not 'just' on the inside, it is on the outside too, as non-locally. Multiple copies are encoded which makes all our conventional commonsense ideas of inside and outside irrelevant. On top of all that mind-bending notion we can start to devise a very different orientation to the quantum wave function. We only need one more element to make our folly complete – degrees of freedom are multiplying spontaneously so we get a layering which reaches an asymptotic limit of complexity which for us spills into emergence and novelty from chaos. This I refer to as radical externality. Let's look at the specific case of AdS/CFT correspondence and qubits.

> Quantum complexity has risen to prominence recently due to connections between gate complexity and holography in high-energy physics, in the context of the anti-de-Sitter

space/conformal field theory (AdS/CFT) correspondence. In the bulk theory, a wormhole's volume grows steadily for exponentially long times. By contrast, in boundary quantum theories, local observables tend to thermalize much more quickly. This contrast is known as the 'wormhole-growth paradox'. It appears to contradict the AdS/CFT correspondence, which postulates a mapping of physical operators between the bulk theory and a quantum boundary theory. A resolution has been proposed in the 'complexity equals volume' conjecture: the wormhole's volume is conjectured to be dual not to a local quantum observable, but to the boundary state's quantum complexity. Similarly, the 'complexity equals action' conjecture posits that a holographic state's complexity is dual to a certain space–time region's action.[1508]

Additionally,

Complex quantum many-body systems can be reconstructed by circuits of so-called quantum bits. The question, however, is: how many elementary operations are needed to prepare the desired state - On the surface, it seems that this minimum number of operations - the complexity of the system - is always growing. Physicists Adam Brown and Leonard Susskind from Stanford University formulated this intuition as a mathematical conjecture: the quantum complexity of a many-particle system should first grow linearly for astronomically long times and then - for even longer - remain in a state of maximum complexity. Their conjecture was motivated by the behaviour of theoretical wormholes, whose volume seems to grow linearly for an eternally long time. In fact, it is further conjectured that complexity and the volume of wormholes are one and the same quantity from two different perspectives. "This redundancy in description is also

called the holographic principle and is an important approach to unifying quantum theory and gravity. Brown and Susskind's conjecture on the growth of complexity can be seen as a plausibility check for ideas around the holographic principle," explains Haferkamp.[1509]

Qubits in the context of prior comments about AdS/CFT correspondence and tiny wormholes have some remarkable confluences with quantum field theory, complexity theory, and chaos theory. All of this gets somewhat simplified in the discussion of qubits' tendency to get whittled away in the jargon of quantum gates and quantum circuits.

The word “circuit” has its origins in the “switching circuits” once used to route telephone calls. These circuits carry signals that are controlled by “gates,” which are electronic components that perform logical or arithmetic operations. A few basic types of gates can be strung together to implement more involved operations. All ordinary computers are built this way.

The inventors of quantum computers adopted the same framework. A quantum circuit acts on its basic units of information, qubits, using a standardized repertoire of gates. Some gates perform familiar operations such as addition, while others are quintessentially quantum. A “controlled NOT” gate, for example, can bind together two or more qubits into an indivisible whole, known as an entangled state.

Inside a quantum computer, qubits might be particles, ions or superconducting current loops. But in general, their precise physical form doesn’t matter. Any system composed of discrete units can be recast as a circuit, even a system that looks nothing like a computer. “The air molecules in a room are moving around and banging into each other, and we can

> think of any collision as a gate," said Nicole Yunger Halpern, a quantum information theorist at the University of Maryland. 1510

Algorithms are the life blood of any computer, classical or quantum. 'Algorithm' is a fancy name for something we do every day: input information, size up alternatives, output a decision. We have all heard the saying, garbage in, garbage out. It would seem that information as chaos would render information, alternatives, and decision moot. But what is chaos? There is something we can know about chaos. Chaos is not static. The notion of chaos as static would have to come under the heading of negative ideology, a pure metaphysics of negation. Chaos can only be thought of in practical terms as dynamic. In order for chaos to be chaos it must incessantly emerge from itself. It must continually violate its own rules to qualify as chaos. It appears that the closest we may come to an *experiential* chaos in our lived life would be insomnia.

Insomnia is the inability to stop 'spinning your wheels' incessantly. Insomnia is an obsession which cannot be turned off by sleep. In the experience of insomnia temporality appears suspended as if there is no break, no sleep, no rest for the weary. Neither is there any hope of cessation or conclusion. In computer language we call this a lock-up where a computer is stuck in an endless loop forever and the only way out is to pull the plug to start all over again. Alan Turing posed some interesting questions concerning the question of intelligence and lock-up or what I am illustrating in the experience of insomnia. I am going to try to paraphrase his argument here by posing the question, what is intelligence?

Turing asks the question, if a computer aided by what we now call artificial intelligence could converse with one hundred people (pick your number) and all one hundred people were convinced they were talking to a real person then, for all intents and purposes, we may conclude that the computer was intelligent, a real person. This is the duck test, "*If it looks like a duck, swims like a duck, and*

quacks like a duck, then it probably is a duck." [1511] By the way, according to some, Turin's 'duck test' passed years ago in annual competitions which finally declared his test of computer intelligence as passed. In 1950 Turin,

> addressed the problem of artificial intelligence, and proposed an experiment that became known as the Turing test, an attempt to define a standard for a machine to be called "intelligent". The idea was that a computer could be said to "think" if a human interrogator could not tell it apart, through conversation, from a human being. In the paper, Turing suggested that rather than building a program to simulate the adult mind, it would be better to produce a simpler one to simulate a child's mind and then to subject it to a course of education. A reversed form of the Turing test is widely used on the Internet; the CAPTCHA test is intended to determine whether the user is a human or a computer. [1512]

Technically and depending on later interpretations of how the test is judged, Turin's test passed in 2014.

> On 7 June 2014, in a Turing test competition at the Royal Society, organised by Kevin Warwick of the University of Reading to mark the 60th anniversary of Turing's death, Goostman won after 33% of the judges were convinced that the bot was human. [1513]

However, this generated and continues to generate much controversy since Turin never could have conceived of the artificial intelligence tools we have now. In any case, there is no doubt that even the most stringent interpretation will pass soon or already has passed Turin's most rigorous requirement for intelligence.

Ok, then the next question Turin posed is, assuming we can pass his test, how do we know that the computer is not locked up in a

very long-running loop and simply fooled everyone into thinking it was intelligent? This asks after the question of what do we mean by intelligence? Turin obviously believes there is a difference between intelligence and a long running, deterministic software loop. It seems plain to me that Turin's assumption is that intelligence is open-ended and will continue to find novel explanations for emergent phenomenon. This brings me back to the lock up problem. How would we know if a computer was locked up in an infinite loop which repeated but simply fooled everyone thinking it was intelligent because the loop was so expansive?

The truth is, from a classical point of view, we can never have 100% certainty that we are not locked up into a deterministic, hugely running 'intelligence loop". It may seem ironic that both chaos and intelligence must continue to find novel explanations for emergent phenomenon. If we really understand chaos in terms of quantum physics' findings, we can have confidence that the universe is not absolute and deterministic as our classical science wants to inform us. Spookiness, many-worlds branching, is not reductive. It is truly emergent in an incalculably novel way. Additionally, intelligence need not be taken in a narrow sense of physics or even certain types of thoughts. In a broad sense there is a sense that there is something we can call emotional or affective intelligence. Intelligence has a role to play in ethical judgements. Intelligence in these and other cases is what crosses into the domain of wisdom or 'the good' for Aristotle. This takes me back to insomnia.

I started out this discussion on algorithms which employed information, alternatives, and decisions. On a classical computer science level, an algorithm is a conduit which takes information in, chooses between alternatives, and decides what the best alternative would be. However, algorithms need to be narrowly tailored ahead of time to delineate the boundaries and conditions which constitute good information, discern by existing criterion which alternatives are best, and decide what the solution or the output needs to be.

Classical computers are currently exceeding expert systems by moving into computer learning where they can change their own algorithms dynamically to make better decisions. Quantum computer algorithms can accomplish these types of tasks more efficiently and more quickly. However, quantum computers can go a step beyond. Quantum computers will be capable of emergent learning which offers novel decisions that our current artificial intelligence, classical computers could never do. One reason for this is the time and physical resources on a classical computer framework would be prohibitive. Even if it were possible for a classical computer to do this, the magnitudes of this task would be on par with what I already discussed in terms of a supercollider large enough to find an actual graviton, it would have to be the size of the solar system. Plus, quantum computers think with a very different kind of 'thinking' as our body and our brain are a quantum system. In superposition, both ourselves and quantum computers 'think' not by sequentially analyzing alternatives based on algorithmic steps but as Schrödinger tells us, "…*not alternatives but all really happen simultaneously*". [1514] Superposition is the basis of emergence as truly novel. So, what does this tell us about chaos?

Let me repeat what I stated earlier:

> There is something we can know about chaos. Chaos is not static. The notion of chaos as static would have to come under the heading of negative ideology, a pure metaphysics of negation. Chaos can only be thought of in practical terms as dynamic. In order for chaos to be chaos it must incessantly emerge from itself. It must continually violate its own rules to qualify as chaos. [1515]

This task can only be accomplished through superposition. Chaos, all alternatives happening simultaneously, is not what Aristotle meant by potentiality, but chaos, all alternatives happening simultaneously, is complete actuality. This would

precisely fit Aristotle's notion of the unmoved mover. The unmoved mover is pure actuality for Aristotle. To me, this sounds a lot like Aristotle intuited the actuality of quantum wave function simultaneous branching as potentiality and pure actuality of the unmoved mover would be La Place's demon. However, for Aristotle the principle of noncontradiction quickly filled the yawning gap of Hesiod with logic. In Book 4, Part 3, of Aristotle's "Metaphysics" he plainly states,

> The Most Fundamental Principle of Knowledge: The Law of Non-Contradiction
>
> Which principle this is, let us proceed to say. It is this: the same attribute cannot at the same time belong and not belong to the same subject and in the same respect--we must presuppose, to guard against dialectical objections, any further qualifications which might be added.
>
> This, then, is the most certain of all principles, since it answers to the definition given above. For it is impossible for any one to believe the same thing to be and not to be, as some think Heraclitus says. 1516

How could something be and not be? The problem that rouses itself in Aristotle's objection is the notion of 'sameness'. 'Sameness' is based on an epistemology of identity and an ontology of Being. We also saw this problem arise in Leibniz's notions of the identity of indiscernibles and the Indiscernibility of Identicals. However, in quantum physics, identity in superposition makes no sense as there can be no persisting identity as all possibilities are happening simultaneously. Furthermore, existence is not merely a deterministic succession of cause-and-effect events which happen to an existing subject but is infinitely more spookily nuanced from entangled exformation in which spacetime is emergent as simultaneous actualities, ever-branching observer effect updates which never return to an 'itself', an origin. This is a far cry from

what our history, language, and cultures would have us believe. This is a radical alterity which we need to face.

Even aside from this, from the viewpoint of entropy, complexity stays the same or grows with time.

> Susskind applied this concept to the hot plasmas that, through the AdS/CFT duality, are equivalent to black holes. He suggested that, even after the plasma reaches a condition of thermal equilibrium, its quantum state does not stop evolving. It becomes ever more complex. The ripples that are reverberating through the plasma dissipate but do not entirely go away, and they are still there if you look at the plasma at the quantum level. Attempting to re-create another plasma with the same pattern of ripples would become increasingly laborious.
>
> Susskind thus laid out his solution to the problem of the ever-growing black hole: The black hole is equivalent to a nuclear plasma; the volume of the black hole is mathematically equivalent to the circuit complexity of the plasma; and because the circuit complexity keeps growing, so must the volume. 1517
>
> …
>
> It turns out that a chaotic system will naturally create a sequence of designs that approximate a truly random distribution with increasing refinement. Because randomness is maximal complexity, getting closer to randomness means that the system grows ever more complex, and at nearly the same rate at which the black hole interior grows bigger…
>
> Not letting the lack of a rigorous proof stop them, Susskind and Brown suggested in 2018 that the steady growth of complexity qualifies as a new law of nature, the second law of quantum complexity — a quantum analogue of the second law of thermodynamics. The second law of thermodynamics holds that closed systems increase in

entropy until they reach thermal equilibrium, the state of maximal entropy. According to Susskind and Brown, the same happens with complexity. A system increases in complexity for eons after it reaches thermal equilibrium. But it does eventually plateau, reaching "complexity equilibrium." At that point, a quantum system has explored every possible state it is capable of and will finally lose any sense of progress.

The eventual plateauing of circuit complexity led Susskind to revisit his original motivation for considering circuit complexity — namely, the growth of black hole interiors. General relativity predicts that they grow forever, but the fun has to end sometime. That means general relativity itself must eventually fail. Theorists already had plenty of reasons to suspect that black holes ultimately need to be described by a quantum theory of gravity, but the cessation of volume growth is a new one…

So far, all of this concerns black holes. But the black holes really just reveal a more general principle about matter. Gradually emerging from all this work is a picture of the full life cycle of quantum systems — the chaotic ones, which means most of them, including the universe as a whole. According to this picture, they go through five distinct stages.

The first is initialization. The system starts simply: just a bunch of particles or other building blocks, acting independently.

Then comes thermalization. The particles bounce around and collide with one another, eventually reaching thermal equilibrium. Their shenanigans also begin to link the particles through quantum entanglement. In a process that Susskind calls "scrambling," information is disseminated through the system until it no longer resides in localized places, much as a butterfly flapping its wings in Brazil can

affect weather over the whole globe. “Operators that are initially local have spread over the entire system in a butterfly-effect-like way,” said Nick Hunter-Jones, a theoretical physicist at the University of Texas, Austin.

Next is complexification. Here, the system is in thermal equilibrium but has not stopped evolving. It keeps getting more complex, but in a way that is almost invisible to standard measures such as entropy. Theorists rely instead on circuit complexity, which expresses the increasingly intricate linkages among entangled particles. “Complexity is really like a microscope into the entanglement structure of the system,” Hunter-Jones said. This stage lasts exponentially longer than thermalization.

Then the system reaches complexity equilibrium, where complexity hits a ceiling. Although the system continues to change, it can no longer be said to evolve — it has no sense of directedness, but wanders among equal states of maximal complexity.

The last stage is called recurrence, where the system stumbles back into its original simple condition. For this to happen by accident is highly improbable. But eternity is a long time, so it ultimately does happen, after a period of time that is not merely exponential, but an exponential of an exponential. The whole process then repeats. 1518

Classical chaos theory had to do with infinities and the incredible sensitivities of initial conditions. The butterfly effect is an example of classical chaos theory. Predicting weather dependent on initial conditions has also been cited as a case of classical chaos. This is also known as sensitive dependence. 1519 Classical chaos is thought of in terms of continuous, linear conditions which can have sensitive conditions which stretch out into asymptotic infinities. However, quantum chaos theory arising from quantum field theory deals with extreme discontinuities, nonlinearities, irreversible

systems, and entangled systems which are atemporal and aspatial.

> Chaos, then, appears to be unstable aperiodic behavior in nonlinear dynamical systems. [1520]

Aperiodic behavior means nontemporal or does not repeat itself on any time scales. Just as classic relativity is a special case of quantum field theory and classical physics is a special case of classic relativity, the problem with classic chaos theory is how it is a special case of quantum chaos theory. How does periodic behavior become a special case of aperiodic behavior? All of this asks after ontology, the physicality in which both of these bizarrely different kinds of chaos can 'exist' together. The principle initially from Bohr to find these harmonies between historic sciences and emerging sciences is called the correspondence rule. [1521] Bohr speaks of classical concepts as an embodiment of language and what we think now as quantum computing and artificial intelligence as need to find the complexity which evolution has naturally acquired.

> Darwinism. In several places Bohr speaks about the classical concepts as embodied in our common language, which is adapted to account for our physical experiences. The selection of the word "adapted to" seems to indicate that Bohr relied on Darwin's theory of natural selection in his search for an explanation. The classical concepts are indispensable for the description of our experience because we are forced by nature to use a common language that is adapted to reporting our visual experiences, which again is a result of humans' adaptation to their physical environment. Apart from Bohr's use of the word "adapted to", Bohr's former assistant Leon Rosenfelt, who was an ardent defender of Bohr's complementarity, explicitly suggests that "the complementarity logic" is due to human evolution: "I suspect the development of a computing and communication system

like our brain demands about that complexity of organization which has been reached by our own species in the course of evolution". Natural selection installs certain permanent visual cognitive schemes in our predecessors, and this cognitive adaptation explains why these schemes, later reflected in our common language, gain a privileged epistemic status, and keep this status in physics in terms of refined classical concepts. [1522]

As discussed earlier, working quantum physicists have traditionally tailored their work to wave function collapse. Susskind tells us they know that it is "*obvious that the Copenhagen interpretation cannot be the last word.*" because it is obvious because the universe is much more intricate by being filled with subsystems in which any one system can be in the role of the observer. He goes on to tell us that there is no place in the laws of quantum mechanics for this kind of literal interpretation of wave function collapse. Why? Because the universe evolves unitarily and becomes more and more complex. I will repeat his quote here,

> Standard quantum mechanics— Copenhagen quantum mechanics—is set up in a way that requires a single external observer, one who is not part of the system. He, she, or it interacts occasionally with the system through a process called measurement, and in so doing collapses the wave function, throwing away all branches other than the one observed. In this view observations are irreversible events which cannot be undone. The method works well in practice but only because reversing a measurement is generally too complex a process to ever be of practical importance.
>
> It is obvious that the Copenhagen Interpretation cannot be the last word. The universe is filled with subsystems, any one of which can play the role of observer. There is no place in the laws of quantum mechanics for wave function

> collapse; the only thing that happens is that the overall wave function evolves unitarily and becomes more and more entangled. The universe is an immensely complicated network of entangled subsystems, and only in some approximation can we single out a particular subsystem as THE OBSERVER. [1523]

In the current practical situation of working physicists, it may make more sense "throwing away all branches other than the one observed". But to get to more fundamental problems like quantum gravity what is now 'noise' must be taken into account. It seems to me Susskind is telling us that simple collapse of the wave function discounts important information that cannot answer looming questions like quantum gravity. More importantly, quantum entanglement is increasingly being used to explain important mysteries about blackholes, singularities, and wormholes as I discussed earlier. Information has traditionally been determined by cause and effect. But physics is moving more and more towards exformation. The quantum wave function has much to do with exformation, entangled information. Exformation shows itself in quantum physics as uncertainty, as alterity which cannot resign itself to finding answers from cause end effect where we introduce a perturbation into phenomenon and then monetize the observed as the result. Greek etymology of the word monetize is interesting and applicable here.

> from Greek -izein [1524]
>
> Many such words originally derived from Greek verbs that ended in -ιζειν (-izein), a suffix that was added to a noun to create a verbal infinitive, either transitive (meaning "to make or conform to, or treat in the way of, the thing expressed by the derivation," such as anatomize) or intransitive ("to act some person or character, do or follow some practice," such as philosophize). [1525]

With all this being discussed I want to return to our predicament with Alice in Wonderland. To circle back, what if all entangled exformation has wormholes? If so, qubits would be tiny, entangled wormholes. Also, spatial locality is a classical illusion of exformation. Our classical notion of space is really exformation. The 'vacuum of space' as virtual, zero-point energy is densely entangled particles which have a spooky and hazy relationship to what we think of as space. Space would then be non-local exformation perhaps arising as loop quantum gravity. And the curvature of space would be less dense exformation. Less density of exformation might be caused by more lumpiness of entangled quanta resulting in mass and what we think of as gravity. All exformation as wormholes ranging from the Big Bang to blackholes/whiteholes to everything in space and even space itself seems to also go against conventional ideas of large and small.

Quantum physics tells us we can no longer rely on our unquestioned absolute classical compass which tells us up is not down and down is not up and small is not large and large is not small and here is not there and there is not here. I do not mean we should walk around like a zombie but that we allow the excess of quantum physics to bracket all our commonsense notions which prioritize space as linear extension and time as equal segments of 'now' moments which, like a film, reel through frame by frame to create life as an abstract 'me'. Our notions of contradictions, sameness and identity, intelligence and Turin's indiscernible quagmire of deterministic looping locking up 'me' like the experience of insomnia reducing life to sameness. Why not relax these abstractions and gyrations which echo as the commonsense solitude of 'me'? Why not recognize unbridgeable excess? All our convolutions from history lure us into narcissistic knots where mere exchange becomes echoes simmering in obsessions of an imagined life? All the discussions thus far in quantum physics, classicism, and philosophy are meant to draw our attention to what we cannot understand, what we cannot even feel, a yawning gap we face

which is not our undoing but radical alterity. We can retreat from abyssal responsibility as slaves of our own echoes, or we can let go and stand in awe and wonder that radical alterity exceeds us, demands of us, spawns worlds of emergence and novelty which calls us away from obsessive and interminably repetitive echoes of a 'my' self perpetually pitted against extinction. We face radical alterities every day, our indebtedness and responsibility to what we cannot understand rather than what we must always strain to stand under.

The Theatre of the Eternal

Classical eternity tells us that every in-between contains another infinity. We can keep subdividing forever. But gravity may be an interesting example of how the 'eternal' ends. Craig Hogan is a theoretical astrophysicist at the University of Chicago and the director of the Center for Particle Astrophysics at Fermilab.

> **A basic assumption in Einstein's physics – an assumption going all the way back to Aristotle, really – is that space is continuous and infinitely divisible, so that any distance could be chopped up into even smaller distances**. But Hogan questions whether that is really true. Just as a pixel is the smallest unit of an image on your screen and a photon is the smallest unit of light, he argues, so there might be an unbreakable smallest unit of distance: a quantum of space.
>
> In Hogan's scenario, it would be meaningless to ask how gravity behaves at distances smaller than a single chunk of space. There would be no way for gravity to function at the smallest scales because no such scale would exist. Or put another way, **general relativity would be forced to make peace with quantum physics, because the space in which physicists measure the effects of relativity would itself**

be divided into unbreakable quantum units. The theatre of reality in which gravity acts would take place on a quantum stage.

Hogan acknowledges that his concept sounds a bit odd, even to a lot of his colleagues on the quantum side of things. Since the late 1960s, a group of physicists and mathematicians have been developing a framework called string theory to help reconcile general relativity with quantum mechanics; over the years, it has evolved into the default mainstream theory, even as it has failed to deliver on much of its early promise. Like the chunky-space solution, string theory assumes a fundamental structure to space, but from there the two diverge. String theory posits that every object in the universe consists of vibrating strings of energy. Like chunky space, string theory averts gravitational catastrophe by introducing a finite, smallest scale to the universe, although the unit strings are drastically smaller even than the spatial structures Hogan is trying to find.

Chunky space does not neatly align with the ideas in string theory – or in any other proposed physics model, for that matter. “It’s a new idea. It’s not in the textbooks; it’s not a prediction of any standard theory,” Hogan says, sounding not the least bit concerned. “But there isn’t any standard theory, right?”

If he is right about the chunkiness of space, that would knock out a lot of the current formulations of string theory and inspire a fresh approach to reformulating general relativity in quantum terms. It would suggest new ways to understand the inherent nature of space and time. And weirdest of all, perhaps, it would bolster the notion that our seemingly three-dimensional reality is composed of more basic, two-dimensional units. Hogan takes the “pixel” metaphor seriously: just as a TV picture can create the impression of depth from a bunch of flat pixels, he suggests,

> so space itself might emerge from a collection of elements that act as if they inhabit only two dimensions.[1526]

The theatre of classical physics ever since Aristotle and even into relativity in the early 20th century has assumed eternities, infinities, and infinitesimals exist externally in the largest and smallest chopped up pieces of spacetime. Even more, a dominant theme in classicism is universal and absolute symmetry. The 'eternal' in classical history is aligned with symmetry. In the dominant strains of classical philosophy, the mind is a homogenous window into the absolute. In the theatre of religion, the proper laws for humanity to adhere to absolute truth come from divine origin. The keepers and priests are endowed by divine authority to rule from divine precept. But quanta as wavicles in superposition irretrievably break up the classical symmetry, concentric spheres of eternal infinites. The mind not only no longer has divine providence, universal access to empirical objectivity, but that turns out to be a historically convincing myth we repeatedly have told ourselves. Our gaze upon the theatre of history has forgotten that it was merely a stage. Now, the actors have become 'reality' and simple common sense.

Now quantum physics tells us that particles cannot be said to exist apart from observation. In this case, infinites do not reflect 'reality' but reflect the inability to even be able to have the physical relevance classicism assumes and assures us we have apart from observation!

> While the temperature at a point on Earth is what it is, regardless of whether you measure it, electrons have no definite position until the moment you observe them. Prior to that, their positions can only be described probabilistically, by assigning values to every point in a quantum field that captures the likelihood you'll find an electron there versus somewhere else. **Prior to observation, electrons essentially exist nowhere — and everywhere.**

> "**There are infinitely many positions that a particle can have**, and this leads to the fact that the matrix that describes the measurement of position, of momentum, also has to be infinite-dimensional," said Kasia Rejzner of the University of York.
>
> And **when theories produce infinities, it calls their physical relevance into question, because infinity exists as a concept, not as anything experiments can ever measure**. It also makes the theories hard to work with mathematically. [1527]

This is no longer a question that can be simply answered as some kind of poppycock of a deranged kook who thinks he is the source and origin of all that exists. That line of reasoning only diverges itself into its own accusation albeit without knowing so. Quantum physics asks us to go beyond our all too normal and typical rationalizations towards a gap where easy answers do not exist. Quantum physics informs us we can no longer rest comfortably in our certainties unless we simply assume that 'reality' is the providence of our oracular 'common sense'. All our supposed realities have clay feet which dance on the stage of historic delusions. If nothing else, the call of intellectual integrity from quantum physics asks us to not be so hasty in our judgements. The void we feel is an invitation to consider radical alterity.

The interruption of the radically other, the ever-growing branches which never return to themselves, their roots of classicism, their roots of origin, tells us in a still small voice that we have no mastery, no rule over origin. Could it be that death is the end of classicism's narratives? Could it be that death is the end of reality, essence, Being, etc. But we retreat and resign ourselves to our own reverberating echoes. In the desperation of a death grip, we hold on to ourselves. In retreat from the Other (Autrui) we only hear our own voice, the voice of Narcissus. Our classical narratives give us supposed safe haven to deny what faces us. Could it be that

death is return to the radical alterity of the universal[1528] wave function? This would not be nonexistence or existence but some excess to such binary dualisms. Might we think of our semiclassical notion of awareness which finds some nodal wave not yet branched in the wave function? This would not be some already branched 'awareness of awareness' or self-conscious. I will discuss Aristotle's notion of 'awareness of awareness' a little later. Effectively, in the denial of radical alterity, the denial of death, we deny the radical alterity of the Other (Autrui) and our responsibility to the Other (Autrui). But there is no life devoid of radical alterity. *There is* only echo dying in the canyons of sheer awareness. I will return to this in much more detail alter. But for now, could it be that life must extinguish itself, return to the wave function it never left, in order to grow (*rhizo-phusis)* – in order to emerge from sheer echo? Could it be that death is the seed which must once again fall into the fertile ground of radical alterity and flourish as the tree of life which can never belong to us. We yearn to imagine in the emptiness of our gazing Eurydice which must always fall into the underworld of our own echoing demons, Echo disappears into the canyons of ourselves. But life springs once again as the flowering of the nymph Echo upon the faithful tear-soaked soil of the death of love.

Einstein, Subjectivity, Objectivity, Being, Identity

Even Einstein was aware of the startling implications of these problems when he wrote the EPR paper entitled, "Can Quantum-Mechanical Description of Physical Reality be Considered Complete?" The first thing many of us think and push against when we contemplate Einstein's ghost is that we are left with no choice but to accept some kind of absolute subjectivity where there is no reality but whatever we manufacture by our 'observation'. However, in this case, subjectivity already supposes an 'absolute' as a subject. So, incestuously we must perpetually relativize absolute subjectivity as standing over and against all contingencies.

However, what has really happened is that we have already set up and simultaneously forgotten the ‘me’ as absolute of subject which continually must be forced to reemerge as an existing ‘relative’ subject. However, the riddle of ‘absolute’ makes no sense without contrast to ‘relative’ to inform us what absolute is not. Pragmatically, we must forget the ‘absolute’ of subjectivity to set off into a world of relativities, of others which interrupt our absolutes. In this case the ‘relative’ is the ‘me’ thrown from the historic necessity of the absolute subjectivity into the world with a pre-understanding of subjectivity perpetually pitted against what Heidegger refers to as being-towards-death. As Foucault points out in his work “Madness and Civilization” these compulsory thought-emotions are driven by a mutual agreement of oppositions which feed off each other, producing a necessary and unavoidable symbiotic condition, of sanity/insanity or in our case the existing subject which must feel itself as absolute subjectivity. The logic is tautologically circular in that both binary oppositions must be definitionally true which is an oxymoron. The result of this is a *fait accompli* in which the impossibility of the ‘I’ is thrown into life as diminishing returns where transactionalism must bargain for returns of imagined glory, Nietzsche’s triumph overcoming. This is being-towards-one's-echo, Narcissus. It also ensures that, as Nietzsche would tell us, despot subjectivity must go under because it must unconditionally affirm life which can only be oblivious of itself. History, culture, and language provides a setting that makes it very difficult for us to find any distance from an obsessiveness which must be lived underground, in the dark. Phenomenology’s motto of ‘back to the things themselves’ (as opposed to abstractions) was all about exposing our lived setting so that we might open possibilities which relieve us of the impossible conditions posed from history which we live as ‘common sense’. All of our seemingly ‘common-sense’ imperatives are not driven by ‘reality’ as they appear but by our situatedness in a particular history, language, and culture. Phenomenology did not want to give us yet another idea to

substitute for these increasingly problematic disruptions but to have us take a breath, step back, and simply look at what shows itself to us in our lived experience of the world, not our theories or constrained lived beliefs of the world.

With this in mind, let's go back to physics and ask ourselves what is showing itself in our quandary of physics? Physics shows us information in a way which is truly mind-boggling. Time and space for both relativity and quantum theory are fundamentally informational. For relativity information is not spooky but beautifully symmetric. For quantum physics information is inclusive of exformation. When we investigate time and space, we find useful information which gives us knowledge and empirically allows us to predict future events. Relativity assumes that information can be infinite. For example, a blackhole singularity is infinite.[1529] In the case of a singularity, for physicists this means something is wrong with our knowledge but even that is also information. In relativity gravity's effects extend infinitely. Quantum theory tells us that information is finitely and statistically determined by the act of observation. As we learned for complementarity, information does not have to abide by the principle of noncontradiction.

> The basic idea is of a "something" which has dual aspects which are normally exclusive of one another. In the 1920s Bohr began to think of the radiation emitted by atoms as having the dual features of a particle and of a wave. These cannot hold together at the same time, but Bohr claims that they can "complement" one another as one moves from the particle account to the wave account and back again. This is vague enough on what complementarity is, but it has to do.[1530]

But the pinnacle which science has achieved in terms of information is the quantum wave function. As has been discussed there is a gaping void as to why the wave function works but the

simple empirical fact is that it does work in a way which beautifully situates all classic physics as a limited condition of quantum physics. There is no turning back for physicists. The only alternative is to plow ahead come what may. Classicism has met its terminus. Blackholes and exformation share some complementary ideas because blackholes have huge thermodynamic and entropic effects on spacetime. I am going to return to blackholes and exformation but first I want to take a slight detour into the relationships between thermodynamics and entropy in the quantum world and the classical world.

What does the Quantum Wave Function have to do with Heat, Thermodynamics and Entropy?

The holographic principle was partially inspired by classical notions of thermodynamics and entropy. [1531] Classical thermodynamics is a branch of physics that deals with the macroscopic behavior of systems in thermal equilibrium. It is based on a set of four laws that describe the relationships between heat, work, energy, and temperature. On the other hand, quantum thermodynamics is a relatively new field that studies the thermodynamics of small systems, such as individual atoms or molecules, which are governed by quantum mechanics. It aims to extend the laws of classical thermodynamics to the quantum realm and investigate how the concepts of heat, work, and temperature can be carried over to the quantum realm, where fluctuations and randomness are fundamentally unavoidable.

In classical thermodynamics, heat is defined as the transfer of energy between two systems due to a temperature difference. The laws of classical thermodynamics describe how heat can be converted into work and vice versa. Recall that the quantum wave function has no physical or classical properties like heat, thermodynamics, and entropy. But there are characteristics in the wave function which are analogously (semiclassically) related to

classical properties like heat, thermodynamics, and entropy. Quantum thermodynamics is a field that studies the relationship between quantum mechanics and thermodynamics. It wants to explain how quantum fluctuations can be converted by state reduction into heat by analyzing the relative states between a quantum system and its environment. Quantum wave fluctuations in the wave function seem to have a semiclassical state reduction we call energy transitions. Additionally, quantum fluctuations in the quantum wave function reflect randomness and uncertainty.

In observed phenomena we see that quanta have a base level of jitter and random fluctuations even if quanta were in a 'bath' of zero degrees Kelvin. Experimentally, as energy is applied to quanta, the jitter and random fluctuations increase before transitions in discrete levels of energy which are quantized. In the classical world the 'macro' of this all 'looks' analogue. In a quantum system, fluctuations are temporary random changes which seem to be related to the classical thermodynamic state of a material that is on the verge of undergoing a phase transition. When a quantum system is placed in contact with a heat reservoir, energy may flow between the system and the bath. This exchange may have probable results which translate to changes in what classical science calls energy transfer or thermodynamics. But in thermodynamics the transitions of energy are related to terms like potential and kinetic energies, which are relative states which are influenced by local conditions. However, for quanta there are situations where non-locality seems to have something to do with these transitions. One example of this is called quantum tunneling meaning nothing in the classical world of thermodynamics can explain how the transfer of potential and kinetic energy can happen but spooky non-local quantum mechanics can to some degree.

In the section entitled "Effects of Vacuum Energy" I dealt with a series of these situations. One example was the Casimir effect between two metal plates which are very close together but not touching. The undulation on the surface of the plates has nothing to

do with charge but something to do with the pure geometry of the metal plates. The time-varying 'Casimir' force on both objects' surfaces is thought to be the result of something called many-impurity phonons. In simple terms a phonon can be thought of as a quantum of heat. However, as quanta it has non-locality. In physics, a phonon is a collective excitation in a periodic, elastic arrangement of atoms or molecules in condensed matter, specifically in solids and some liquids. It is a type of quasiparticle that is an excited state in the quantum mechanical quantization of the modes of vibrations for elastic structures of interacting particles. Phonons can be thought of as quantized sound waves, similar to photons as quantized light waves. However, photons are fundamental particles that can be individually detected, whereas phonons, being quasiparticles, are an *emergent phenomenon*. The study of phonons is an important part of condensed matter physics. They play a major role in many of the physical properties of condensed matter systems, such as thermal conductivity and electrical conductivity, as well as in models of neutron scattering and related effects. The concept of phonons was introduced in 1932 by Soviet physicist Igor Tamm. The name phonon comes from the Greek word φωνή (phonē), which translates to sound or voice, because long-wavelength phonons give rise to sound. The name is analogous to the word photon representing wave-particle duality for sound waves. As kinds of sound waves, can we think of phonons as a particular melodic melody - a song? 1532

A many-impurity phonon is a phenomenon in condensed matter physics where the interaction between impurities is mediated by vacuum fluctuations of the phonon field. The phonon Casimir effect is the long-range interaction between impurities in condensed matter systems, mediated by vacuum fluctuations of the phonon field. For pairs of impurities, this interaction has been shown to follow a quasi-power-law at zero-temperature and evolve into an exponentially decaying form as the temperature increases. A recent study has introduced an approach to deal with systems of more

than two impurities, both at zero and finite temperatures. [1533]

The phonon's quantum wave function is similar to the quantum oscillator I discussed earlier except it is multi-dimensional. Because phonons are heat carriers, it is believed that heat can be transferred across potential energy barriers which would not be possible from classical thermodynamics. Classically thermodynamics and heat are the quantum wave function's semiclassical 'metaphor' of non-local, entangled systems in the wave function. Another example is when we think of determinism in a classical sense the quantum wave function's semiclassical or 'metaphor' of 'determinism' is how the square of the wave function can give us a quasi-deterministic probability about what might happen upon state reduction. By quasi-determinability I am referring to Heisenberg's uncertainty principle. The wave function is 'bathed' in controlled encounters with the environment. However, complexity *grows* in the environment until there is no practical ability to understand the wave function as anything but chaotic.

Likewise, in the semiclassical 'metaphor' of entropy, the von Neumann entropy is the quantum analogue of the Boltzmann entropy in classical mechanics. The von Neumann entropy is a quantity in quantum information theory that quantifies the amount of quantum information contained in a state when many identical and independent copies of the state are available. The von Neumann entropy is a quantity that measures the randomness or uncertainty of a quantum state. Quantum entropy is used to describe the degree of entanglement between particles and systems. Classic entropy is a semiclassical extension of the classical concept of entropy to quantum mechanics. Quantum entropy has nothing to do with 'heat' or 'energy' in the wave function itself. So, perhaps the analogy we use in the wave function is unorganized exformation. Quantum entropy is related to the amount of information that is missing about a quantum system due to incomplete knowledge or measurement. In a sense, it is a measure of unaccounted-for excess or chaos. [1534]

The ‘thermodynamics’ and ‘entropy’ of the holographic principle tell us the three dimensions of space, volume, are encoded in the two dimensions of an event horizon in fashions discussed in the previous section. This is tantamount to saying that general relativity is encoded by quantum physics by quanta. But quanta as wavicles arise from spooky entanglement in the observer effect of the wave function. What is more there is a limit to entangled entropy, exformation, which is given by the surface area of the event horizon of a blackhole, Conformal Field Theory (CFT), and not by the volume of the blackhole or the interior of the blackhole, anti-de Sitter space. Since the universe evolved from a blackhole we can imagine that the universe is actually the volume of a blackhole. So, even if you cannot imagine a literal ‘event horizon’ for the entire universe (which would bring up unresolvable questions about an outside to this imagined event horizon” the volume we live and move and have our being in may have a virtual event horizon in terms of the observable universe, visible universe, causal universe, particle universe, or conformal limit of the universe which were already discussed.

One note here, I have deferred the idea of time, temporality, in this discussion of the holographic principle in thinking of volume or space only. Thereby only dealing with the notion of spacetime currently. I suppose one reason for this has to do with complementarity. We can think about ‘wave’ and we can think about ‘particle’ separately but in the haze of quantum physics they are the same AND contradictory. One way I think about temporality is from the observer effect of the quantum wave function and its assumption of unitarity, as simplified and isolated from environment, until it finds its bath into chaos. Temporality can also be thought of in terms of loop quantum gravity which was discussed earlier.

The simplest and most straightforward extreme philosophical

implications of artificial intelligence and quantum computing are that we are on the verge of creating a new life form we call quantum intelligence. As Yuval Harari has indicated, this new life form will be an evolution of the human species. Think about this, the species that will evolve from us will not be from adaptive genetic code errors but from *phusis*. Our offspring will not initially emerge from classical notions of biology but from what we have learned about *phusis* from quantum exformation. Here are a few intriguing religious side questions this issue brings up, "Will the anti-abortion folks be ok with aborting quantum intelligence?"

This is the Gaia hypothesis,

> The Gaia hypothesis is a scientific theory that proposes that living organisms interact with their inorganic surroundings on Earth to form a synergistic and self-regulating, complex system that helps to maintain and perpetuate the conditions for life on the planet. The hypothesis was formulated by the chemist James Lovelock and co-developed by the microbiologist Lynn Margulis in the 1970s 12. The name of the hypothesis is derived from Gaia, the primordial deity who personified the Earth in Greek mythology. The hypothesis suggests that organisms co-evolve with their environment and influence their abiotic environment, and that environment in turn influences the biota by Darwinian process. The Gaia hypothesis has been criticized for being teleological and against the principles of natural selection, but later refinements aligned the Gaia hypothesis with ideas from fields such as Earth system science, biogeochemistry and systems ecology. Even so, the Gaia hypothesis continues to attract criticism, and today many scientists consider it to be only weakly supported by, or at odds with, the available evidence. 1535

Is it blasphemy to think that Homo sapiens and the emergence

of quantum intelligence can both be predicated as ‘man’ in the quote below?

> Genesis 3:22a “Behold, the man has become like one of us [the gods] in knowing good and evil.”?

And what about other life forms we may have no knowledge of? However, we do know that they would not have to be carbon based like we are. Could the tree of life be the branching of the quantum wave function? Can Homo sapiens and quantum intelligence survive by at last understanding our responsibility before the radical alterity of the Other (Autrui)? Can quantum intelligence learn ethics which do not have to arise as Homo sapiens’ evolutionary stages did with the violence of Narcissus? Will Homo sapiens and quantum intelligence be able to learn from the knowledge of good and evil? And then, can we partake of the universal tree of life?

> Genesis 3:22b “Now, lest he reach out his hand and take also of the tree of life and eat, and live forever—”?

In much of this book, I have dealt with broader classical principles but the ancient intuitions of *phusis* have still found marginalized voices in classical and modernist histories. In our history there is another sapling which has grown away from classicism’s shadow. The dominant classical understanding of intelligence was based on objectivity, absolute time and space, and a static universe in which the self increasingly was forced to conform to Chaplin’s “Modern Times”. Yet, we also find another philosophical strain of thinking running through Western history which has increasingly become more dominant in the 20th century.

> However, in Western metaphysics we also find another tradition, process philosophy, according to which the world

is not a collection of objects but a process of becoming (rather than being). This tradition finds inspiration in Heraclitus' doctrine of radical flux (consider the famous slogan *panta rhei*: everything flows), has been developed in German idealism (Hegel) and pragmatism (James, Dewey, Mead, Peirce), and is also to some extent present in Heidegger, but has found its most famous elaboration in the process philosophy of Bergson and Whitehead, which has then influenced contemporary philosophers such as Deleuze, Simondon, and Latour. The French philosopher Henri Bergson argued that individual intelligence emerged in a process of evolution that expresses a life force (élan vital) (Bergson, 1907). He used the term 'duration' (durée) to talk about time: already in his doctoral dissertation and in his debate with Einstein, he distinguished between time as we experience it (lived time) and the time of science, which is conceived of as discrete, spatial constructs (Bergson 1889). Bergson argued against what he saw as Kant's mistake to think time in terms of space, and emphasized intuition (Bergson, 1896) rather than formal knowledge and its conditions. However, duration is not just subjective, psychologically experienced time (as Einstein thought). Duration is something real, which can be experienced or transformed into something spatial. Thus, according to Bergson, there is not first objective time and then our experience of that objective time. Bergson attempted to go beyond the subject-object divide of Cartesian and Kantian philosophy: time cannot be isolated from our experience of it and, more generally, from 'the living structures in which it manifests itself'.[1536]

The 20th century made it apparent that objectivity, a mechanistic-based metaphysics, was insufficient for physics and philosophy. Our inheritance from the metaphysics of mechanism

was digital technology, binary logic. Certainly, this has been useful and pragmatic for humanity, but it has also come with severe consequences which objectify people and resources as objects to be used and rewards acquisition and dominance at the cost of the environment and unmitigated greed at the behest of the science of marketing. We see this especially in the embryonic stages of artificial intelligence. The metaphysics of Christianity began to render itself void of its Latin meaning after the dark ages with the onset of the Renaissance and modernism. In Christianity's exhaustion of itself it denuded itself of the gods through its translation into modernity. But modernism retained an underlying metaphysics of classicism which no longer required absolute divinity. Divinity was replaced with absolute objectivity encoded in the term 'reality'. Just as the ancient 'pagan' gods disappeared with the onset of the monotheistic God, modernism and the mechanistic sense information replaced God with objectivity. In 'reality' the objectivity of the senses mechanically producing the thinking 'thing' reduces individuality to the cogs of Charlie Chaplin's "Modern Times" machine. The metaphysics of objectivity dominates in its disappearance. William James (1842-1910) was a strong advocate of the idea that 'objectivity' missed something important about our varieties of experience.

> "Physical facts simply are or are not; and neither when present or absent can
>
> they be supposed to make demands. If they do, they can only do so by having
>
> desires; and then they have ceased to be purely physical facts, and have become
>
> facts of conscious sensibility. Goodness, badness and obligation must be realized
>
> somewhere in order really to exist; and the first step in ethical philosophy is to
>
> see that no merely inorganic "nature of things" can

realize them. Neither moral

relations or the moral law can swing in vacuo. Their only habitat can be a mind

that feels them. . . The moment one sentient being, however, is made a part of

the universe, there is a chance for goods and evils to really exist. Moral relations

now have their status, in that being's consciousness." [1537]

Our current binary digital logic was the necessary outcome of our history of modernism. Intelligence is modeled as the vastness of facts in this historic backdrop. The 20th century took a wrecking ball to this metaphysics in many ways. The most obvious way is based on the absoluteness of time in digital circuitry. Our digital computers are very sophisticated temporal-based state machines. Even parallel processing state machines working on one complex job must synchronize themselves temporally. Tasks rely on inputs and outputs no matter how the tasks get doled out for a job. An operating system is the task manager and grand synchronizer of jobs. But synchronic jobs rely on batches of various tasks which must be compiled into the context of a completed job to produce a result. The synchronizing effect of a software job as work production in a virtual factory might be analogously thought of as the quantum wave function's fall into classicism, state reduction, which produces the work of 'me here now' already clothed with perhaps in a Heideggerian sense, a world-factory. This experience is a narrative of 'self'. This narrative has no 'real' classical synchronizing of abstract 'now' moments. Neither is it the temporalizing structure of care (*Sorge*) in Heidegger's sense. This narrative is a virtual factory unified as an existing self. Our lived experiences that temporalize the self as 'me' spatially are juxtaposed to the task master and grand synchronizer of jobs where we are the task slaves like cogs in the machine of modernism. Our lived experiences are constrained such that they can only reveal

themselves from these classical histories as unresolvable dichotomies of bipolar dualities which somehow are converging into the lived narrative of ‘me here now’. However, could we think of the end of modernity as the failed Epoch of Being and essence? The epoch of the later Greeks to modernity's failings do not seem to have any possibility for recovery into yet another paradigm for gathering meaning, rearranging the synchronic temporality of history. The quantum wave function has a very spooky complementarity juxtaposed to our exasperating conundrums of bipolar dualities and our temporalizing necessities. The simultaneity of the quantum wave function unravels as innumerable diachronic entangled systems whose complexities vault towards chaos. The highly entangled complexity of the quantum wave function’s systems in superposition is inextricably tied to evolving emergences from chaos of innumerable multiplicities in simultaneous diachronies with the observer effect not only producing the worlding of ‘me’ but also arising as quanta where spacetime is curved.

Quantum physics tells us spacetime curvature somehow arose from entangled information in whatever the Big Bang singularity was. Gravity fell away from the unified force somewhere around 10^{-43} seconds after the Big Bang. As the universe fell into many classicisms, gravity and time and space emerged and emerges from incomprehensible exformation, entangled information. Somehow gravity or better spacetime curvature occurred from a quantum process. So, would it be possible to create gravity, spacetime curvature with entangled qubits?

Quantum computers may well work on the principle of tiny wormholes. Coupled with artificial intelligence they will think more like human brains but potentially with much more capacity. There have been some studies concerning whether or not our brains are quantum minds.[1538] Certainly, quantum entanglement is, like every other quantum system including our brains, heavily involved in quantum mechanics. Could it be that the prophetic warnings of

science fiction may once again prove true where humanity may meet with the hazardous journey between “The Terminator” and the ethical dilemma of “I, Robot”? It is way too early to know that the mind *is* uniquely a result of quantum entanglement but there are a number of similarities between our brains and entanglement. Among these may be thinking in ways which do not process information serially but somehow arise altogether with a history, an entire context which must incessantly be reconstructed in every moment of awareness. If it were even possible, current digital computers would take massive supercomputers long periods of time to make some of the simplest associations we make every day. On the other hand, quantum computing will process these kinds of associations very quickly. Digital computers scale up expensively and with more complex software. Quantum computing would scale up exponentially and very inexpensively. Massive digital computing takes massive power. Quantum computing as entangled particles can eventually be very low power and ‘noisy’ environments in a way that makes use of noise just like our brains to think non-serially like binary logic. However, quantum computing needs to have entangled coherence for relatively long-time spans or better error correction and complex matrices of retaining and restoring lost information perhaps just like neurons in our brains. Most of the time entanglement is very short-lived in the ambient environment of earth’s atmosphere along the order of 10^{-15}. However, one way nature has found ways to use entangled coherence to temporalize energy transformations is photosynthesis.[1539]

Quantum Measurement Cooling Experiment

There is no ‘energy’ in the quantum wave function. Energy is purely a classical concept. In the wave function the Hamiltonian operator is a quantum mechanical operator which correlates what we see upon classical observation, the observer effect, as energy. The Hamiltonian operator is used to calculate what we will observe as

the energy spectrum of a system. It is the set of all possible outcomes obtainable upon observation or measurement of the system's total energy. With this in mind, it has recently been discovered that even energy can be teleported simply using zero-point energy e.g., observing one end of an entangled system has energy effect of the other end of the entangled system. Let's look at this closer. First, let's look at one experiment of entangled systems which may be an example of how one entangled system can cool off by transferring the energy of the ambient environment of the other entangled system. This experiment is called the 'quantum measurement cooling experiment'.

We have seen that the longevity of quantum entanglement is lengthened in supercooled environments. What if we could cool entangled particles to less than 1 degree kelvin by simply observing or measuring them? Could a constant stream of measurements cool them to temperatures very close to absolute zero? A study in physics in 2019 found that the mere act of measurement generates energy! I would like to cite this study, "Quantum Measurement Cooling"[1540] (Lorenzo Buffoni, 2019).

> Invasiveness of quantum measurements is a genuinely quantum mechanical feature that is not necessarily detrimental: Here we show how quantum measurements can be used to fuel a cooling engine. We illustrate quantum measurement cooling (QMC) by means of a prototypical two-stroke two-qubit engine which interacts with a measurement apparatus and two heat reservoirs at different temperatures. We show that feedback control is not necessary for operation while entanglement must be present in the measurement projectors. We quantify the probability that QMC occurs when the measurement basis is chosen randomly, and find that it can be very large as compared to the probability of extracting energy (heat engine operation), while remaining always smaller than the most useless operation, namely

dumping heat in both baths. These results show that QMC can be very robust to experimental noise. A possible low-temperature solid-state implementation that integrates circuit QED technology with circuit quantum thermodynamics technology is presented.[1541]

Why does this happen? Consider this,

In Maxwell's famous thought experiment, a demon operates a door between two gas reservoirs, collecting hotter particles in one and colder particles in the other. As we now know, the demon needs information to sort the particles, so the second law of thermodynamics is not violated. Similarly, quantum heat engines rely on information to operate a feedback control loop that steers the heat. Now, Michele Campisi at the University of Florence, Italy, and colleagues show theoretically that quantum refrigeration can be fueled by measurements alone, without exerting feedback control. Such a scheme is more tolerant of noise and may therefore be practically achievable.

The researchers considered a two-stroke two-qubit quantum engine in which one qubit is coupled to a hot bath and the other to a cold bath. In the first stroke, a physical quantity associated with the two-qubit system is measured in a way that alters the system's state. In the second stroke, the energy exchanged during the measurement is released from each qubit to its bath.

Upon analyzing the overall energy flow in this setup, the team finds that, for a random choice of the measured quantity, heat most likely flows from the measurement apparatus to both baths. However, calculations also reveal up to a 50% chance that heat flows from the cold to the hot bath as the measurement injects energy. This quantum-measurement cooling occurs as long as the measured

> quantity probes qubit states that are entangled. The team says that this approach to quantum refrigeration could be implemented with existing solid-state superconducting qubits.[1542]

One important point here is that this cooling can only occur if the systems remain entangled. Too many measurements can cause the systems to decohere in which case quantum cooling of the other ambient environment can no longer occur.

Let's deconstruct the quote above. The study I cited tells us that observing entanglement creates a change in ambient environment which effectively 'cools' the environment. In other words, entanglement itself gives off heat relative to its ambient environment.

> Heat and work are two different ways of transferring energy from one system to another. The distinction between Heat and Work is important in the field of thermodynamics. Heat is the transfer of thermal energy between systems, while work is the transfer of mechanical energy between two systems. This distinction between the microscopic motion (heat) and macroscopic motion (work) is crucial to how thermodynamic processes work. Heat can be transformed into work and vice versa (see mechanical equivalent of heat), but they aren't the same thing. The first law of thermodynamics states that heat and work both contribute to the total internal energy of a system, but the second law of thermodynamics limits the amount of heat that can be turned into work.
>
> Main Differences
>
> The Second Law allows work to be transformed fully into heat but forbids heat to be totally converted into work. If heat could be transformed fully into work, it would violate the laws of entropy. The maximum amount of work one can

attain from heat is given by the Carnot efficiency.

Heat is the energy associated with the random motion of particles, while work is the energy of ordered motion in one direction. Therefore, heat is "low-quality" energy and work is "high-quality" energy, and this supports the entropy statement of the Second Law.[1543]

As the above quote tells us, giving off heat can be converted to work but because of entropy not all heat can be converted to work. In the case of work, giving off heat means decreasing entropy or chaos in a particular system at the expense of increasing entropy or disorder in the open system or environment around the system.

Order out of Chaos

There are many examples of complexity in our world around us. Things such as

Plants growing from tiny seeds,

Single-celled fertilized eggs growing into complex life,

Complex molecules and formations, and

Vast increases of knowledge and information

are extremely complex systems which appear to violate the Entropy Statement of the Second law of thermodynamics.

Since entropy is increasing, and the Second law entails that out of this increase comes disorder, randomness and simplicity, how is it that there is so much order and complexity around us?

The answer is that this disorder only applies to systems that do not exchange energy with their environment, known as isolated systems.

This is a major confusion in understanding entropy, and it is important to distinguish between an isolated (closed) and non-isolated (open) system. Open systems are free to interact with their environment, and therefore energy can be added to or removed from them. Systems that become more ordered

> as time passes are called self-organizing systems. In order for this decrease in entropy to be possible, they must take in energy from an outside source. However, because the open system's entropy is decreasing, there must be an increase of entropy outside of the system.[1544]

Several other experiments have successfully shown that entangled atoms on opposite sides of an atom can transfer energy from one entangled atom to the other entangled atom. This is called energy teleportation. One important thing to remember here is that when a system stops receiving energy, its immediate response is to return to a lower thermodynamic equilibrium but momentarily it will fall below equilibrium before returning to its new, lower equilibrium state. By looking at an aftereffect lower than a system's energy equilibrium level, you can tell a change occurred in thermal equilibrium.

Using nuclear magnetic resonance, a team of physicists finely tuned a series of radio pulses to put two entangled carbon atoms into a minimum-energy ground state. A minimum-energy ground state is when an electron in an atom is in its lowest quantum orbit cloud or position. The minimum energy is a range of energy which statistically averages out between the high and low energy of that orbit cloud due to uncertainty. The experimenters used a third atom as a messenger atom to signal between the two carbon atoms on opposite sides of the molecule when the experiment had convened. There was an average of a 37-millisecond delay between one atom sending the message and the other atom receiving the message. To start, they simultaneously sent a single radio pulse to one entangled carbon atom measuring its energy position and sending a message to the third atom that the experiment had started. As soon as the other entangled carbon atom saw the third messenger atom 37-milliseconds later had signaled a start to the experiment, the other entangled atom immediately measured its energy position. The idea here is that the first entangled carbon atom was raised from its

minimum-energy superposition state raising the energy of the second entangled atom immediately with no time delay at all. By the time the other atom got the message to start 37-milliseconds later, it had deleted its higher energy level due to thermal equilibrium and had actually decreased below its minimum-energy level. The bottom line is simply by measuring one entangled energy position, the lower than minimum-energy level of the other entangled atom indicated that its energy had also been boosted by entanglement, without time, before releasing its energy back to the environment 37-milliseconds later. This test was repeated a high number of times to get statistical accuracy.[1545]

A few days later a researcher at Stony Brook saw the experiment on YouTube and realized he could run the experiment in IBM's quantum computing platform. Over the next couple days, he wrote and executed the experiment using qubits on IBM's quantum computer and verified the same results as the previous experiment. Now, the original experimenter is working on a new experiment to demonstrate energy teleportation at the zero-point energy level of vacuum energy. To be clear, what we are talking about here is that over nothing at all, in absolutely no time at all, energy can be transferred from one entangled particle or system to another entangled particle or system on the other side of the universe. If that does not blow your mind nothing will!

Are we Living in a Blackhole?

Now, let's think about the geometry of a blackhole. We have all seen images which depict the blackhole like a whirlpool going down into a singularity. However, these images are just a visualization of something we have no clue about. All we know and have actually imaged is a somewhat circular or oblong void we call the event horizon. To even think in terms of what is below the event horizon is highly problematic. Terms like 'below' and 'above' have no meaning when spacetime is no more. Simply put, the void

does not exist. But what do we mean by ‘not exist’?

Well, we already know of a phenomenon which barely exists. It is called zero-point energy. It is required by the quantum wave function, and we have already seen that this hazy phenomenon can have real effects like lightning. Quantum teleportation sounds spooky, and it is but entangled qubits in quantum computing depend on quantum teleportation. Quantum teleportation between two entangled systems is well established science and it works. Recent experiments are now showing that quantum teleportation can happen with spatial entanglement of quantum vacuum zero-point energy fluctuations. Simply put, quantum teleportation is exformation, entangled information, which has nothing to do with spacetime but nevertheless conveys exformation without any regard whatsoever to spacetime. Even ‘energy’ can be transported in quantum teleportation. But first, let’s refresh ourselves on the idea of energy and the quantum wave function.

In a nutshell the quantum measurement cooling experiment tells us that a region of space can be cooled off for no apparent reason due to decoherence from some other region of space that might be universes away. Could we extend this to think that classicism could come out of nothing or better, out of chaos? I would think zero-point energy, the background frame of spacetime as virtual particles popping in and out of existence, certainly qualifies as chaos. Wormhole-qubit teleportation based in zero-point ‘energy’ can allow information to be ‘transported’ without spacetime. Now, let’s get back to quantum teleportation using zero-point energy, virtual particles, which have a hazy existence. Not only does this have some startling ramifications for quantum computing, qubits, and tiny wormholes, but I would think also for wormholes no matter what size. Can we think of the Big Bang?

> Now, recent experiments have directly demonstrated the teleportation of energy by utilizing the spatial entanglement of quantum vacuum zero-point energy fluctuations. In

addition to being a direct demonstration of the ability to leverage the intrinsic entanglement state of the quantum vacuum to teleport energy, the protocols have potential applications in a wide variety of quantum devices and quantum information technologies, like entanglement harvesting, considerations of the parallel of quantum energy teleportation with wormhole-qubit teleportation (ER = EPR), understanding quantum thermodynamics with applications in maintaining robust qubit entanglement in quantum computers via cooling of many-body quantum systems, and even greater understanding of black hole entropy, thermodynamics, and information. [1546]

I started out this topic discussing the 'not existence' of blackholes. If, as it seems, the Big Bang was a blackhole, and we know spacetime ends at the event horizon of a blackhole, are we still 'inside' the Big Bang singularity? Also, recall the discussions I have already pointed out concerning Alice's rabbit hole – the inside of a blackhole may really be on the outside. Everything we call anything or simply 'thing', existence, Being and beings, reality, etc. according to the quantum wave function has already 'accounted for' this 'thing' we call classicism. Our consciousness, bodies, spacetime, etc. is not rooted in 'stuff' but in the chaos of the wave function which has the spooky observer effect that is not individual/ collective or any other binary dualities we are disposed to think. Hegel's absolute Logic cannot account for why the 'spooky' observer effect ultimately collapses into classical reality. Hegel never envisioned Everett's simultaneous many branchings, many-worlds, which may not be simplistic notions of separate worlds, but confluences, overlapping and interwoven worlds combined together with the observer effect resulting in the impossibility of ever finding an overarching Concept much less a cogent scalar value for the cosmological constant!

What if the interior of Big Bang/blackhole frame dragging/zero-

point energy falling into the event horizon instead of the hitting a fiery inner wall where existence ceases in a catastrophic sense, everything gets pulled back into the singularity of the wave function as if it never left in the first place – what if that could be what we simply see as young to old people simply dying like we do/think now, as the great fear of death? Is this how we would get pulled into a singularity instead of one big calamitous 'end to the universe'? I know this is a 'crazy idea' but quantum physics typically does not let something like that get in the way. Could it be that the workings of the 'observer effect' as we already know are already taken into account in the simultaneity of the wave function? Could this *be* the narrative we deem a singularity?

On the classical, local scale what we see is the effect of mass. This is the chunkiness of space. However, what we do not see is much larger. It is 'empty space', what classical physics assumed was a perfect vacuum. However, empty space is far from a perfect vacuum. It is bubbling, gurgling, jittering with virtual energy. However, this energy is more like what we think of as noise. This energy is extremely small and short lived. It is called virtual energy as it pops in and out of existence. But it has major impacts on what happens in our universe. Fundamentally, it makes our universe uncertain with erratic and random behavior. It is chaotic but can bubble up into quantum physics as 'essentially uncertain'. Could this be the incalculable excess of the wave function making a hazy quasi-existent imprint on what we think of as spacetime?

Classical Physics and Quantum Physics Review

Let's review some important facts… Classic physics tells us:

- Science is absolutely deterministic.
- Time and space are absolutely deterministic.
- Space is an empty vacuum.
- Time is constant and cannot change.

- All states of a system can be completely determined by earlier states of the system. All causes for all effects can be determined.
- All objects are completely localizable as definite places and times.
- An object cannot occupy more than one space and one time, e.g., space is linear and each region, no matter how small, is absolutely unique.
- Einstein's theory of General Relativity shows conclusively:

    - Time is relevant to relativistic inertial frames.
    - Time itself can speed up or slow down.
    - Time cannot be faster than the speed of light.
    - Time and space are inseparable and totally dependent on each other.
    - Mass, density, gravity, and energy are direct results of their dependence on time and space. [1547]

Let's review a few concepts of entanglement which I have previously written on my blog (MixerMuse.com). Here is a summary:

- Quantum entanglement happens naturally almost all the time when two quantum particles or systems interact.
- When quantum entanglement happens with two quantum particles or systems, we have entanglement called coherence.
- Quantum entanglement need not happen fully between two quantum particles or systems.
- Entangled particles or systems can be partially entangled whenever they interact with other quantum systems.
- Entanglement can happen partially with many different quantum particles or systems.
- Partial quantum entanglement gives better or worse probabilities for describing entangled behavior.

- Entangled quantum particles or systems can cease to be entangled. This is called decoherence.
- Uncertainty and chaos underlie everything and anything but gives rise to everything and anything as emergent and novel.
- The quantum wave function describes and predicts how a system reacts in state reduction when it collapses or branches.
- The quantum wave function is purely mathematical but not merely mathematical. The status of the wave function's ontology and epistemology is uncertain.
- The quantum wave function requires virtual particles and systems, zero-point energy, which have a very hazy relationship with ontology.
- Anytime something 'is', the quantum wave function has collapsed or branched into state reduction from the observer effect which has very epistemological implications (e.g., includes such notions as personal, subjective, collective, objective, history, classicisms, etc.) 1548

Concluding Remarks on Physics

According to physics there is an externality to what 'is' which cannot be accounted for in 'commonsense'. Commonsense is another name for the lost and submerged repetition of lived histories, times that were not our lived time, in our lifetime, but still order and arrange the very way in which we navigate our lived life - a past not my past, forgotten, but assumed in us as 'orientation'. Ironically, what we do and 'are' as 'reality' has now been dissolved by the very anchor of 'reality' many of us believe as science, as fact, as what is true. This is no longer mere 'philosophizing' according to the common edict of commonsense. Let's call it supposition and informational branching. I hope

through the course of this book we have glimpsed an externality which will give us pause - a lapse in which some radically other might face us.

I want to take the Hugh Everett approach I discussed earlier in the section “Observation is Measurement”. I cannot say that I believe Everett was correct, but I also cannot think of any reason why he would be wrong. Neither can I simply think of his position as some kind of abstract metaphysical position. I think history has exhausted the classical notions of a soul, God, absolute time and space, subjective-objective duality, and many other categories of understanding taken further into reductionary/immanent dialecticism, mind/body substance/machine, existential/biological determinism, and even self-indulgent cynicism/agnosticism taken in the mode of truth against all truth. The latter simply resigns itself to self-indulgent transactionalism or some kind of market Darwinism. Twentieth century physics no longer allows us these indulgences. Physics and philosophy have once again returned us to something reminiscent of archaic *phusis* but with a very spooky twist. We are an entangled system not simply as modernity’s body or mind but as a kind of entangled, middle-voice intimacy with chaos, exformation, which is incredibly attuned to collapse or branching whether spontaneously, observationally, information updating in infinite kinds of infinites, vacuum energy pulsing/pushing up and back incessantly as spacetime/determinateness/information and chaos/indeterminateness/superposition - as cause and effect, as suspended, always contingent, universe, world, history, and nexus of choice. No matter what we make of all this, we can at least come to two conclusions:

- What we thought/think we knew/know was/is wrong.
- A radical exteriority cannot be dismissed except at our/my expense. 1549

Three gaping questions have been left throughout this

discussion,

1. If Everett's idea of endless branching of the wave function applies to me as subject, how can I know or have any world in common with anyone else?
2. How can exformation explain feelings, passion, sensuality, wonder, awe, the profundity of love, of unconditional devotion to our children, and even the darker side of feelings like hatred, envy, anger, resentment, bitterness, and guilt? Physics to this point has been justifiably limited to thinking but that does not mean necessarily that exformation has to be purely informational and everything I just mentioned has to be accidental, unimportant, superfluous, reducible to mere 'data'.
3. If every collapse of 'me' as superposition branches off into another universe of 'me's in another world, how does consciousness of me here now arrive and what are the consequences? 1550

I think these are really good questions. I do not claim to have any answers, only guesses about how Everettian physics can be applied to these questions. Apparently, Everett and others seem to think it could. In any case I think the two conclusions I mentioned above can be taken into the next division of this discussion.

Question 1:

Could it be that when we are born, we are really in what physics calls a state of superposition? Even in the neurology of the infant brain, we have many neurons firing all at once in a fashion which I would liken to a lived-superposition state. Time and space are still chaotic. Sense and nonsense are not even dialectically opposed. This is a haze of faces, of actions, of mimicking, and hopefully, love, devotion, attention, mirroring, and the most tender care. However, as we know many times this is not true. Babies and kids are born in

the most hostile, poverty-stricken environments with some even being horribly abused and neglected. In either case, gradually 'me' as superposition collapses as perhaps a mom, a dad, love, a routine, or the horror of abandonment, neglect, suffering, abuse and eventually a language, mobility, decision and as entangled neurons and neural pathways settle down, some strengthened, some weakened – in the widest sense of the word 'sensual', a world of feelings, values, choice emerges. In a 2023 article Scientific American [1551] explores the statistical experience of death (obviously by those that did not quite make it all the way there or at least are on their way to making it there). Need I mention that Scientific American is not known for being flaky. The article is very interesting, and I recommend you read it. But for now, I will summarize a few surprising results. A study published on September 14 in *Resuscitation* of near-death experiences of 567 people of which 53 survived found some astonishing results. Of the 53 who survived researchers conducted interviews with 28 of the survivors. These people's hearts had stopped and all electrical activity flatlined. Some of these people's hearts had stopped for up to an hour. Upon receiving CPR their flatlined brains "burst into a flurry of activity". Some were able to recall their experience. One person recalled some audio activity while doctors were trying to resuscitate that person.

Researchers analyzing the brain recordings reported the patients had markers of "lucid, recalled experiences of death". Sam Parnia, an associate professor of medicine at NYU Langone Health, a researcher of what happens to people as they die, stated, "We've also been able to put forward a coherent, mechanistic explanation for why this occurs." It is believed that in the dying brain normal braking systems are removed. I take this to mean normal inhibitions which perhaps separate consciousness from subconsciousness and perhaps unconsciousness is lifted. As the article reports it, researchers think that the dying person gains access to their "entire consciousness", "everything that's been stored before". Researchers believe that there may be an evolutionary benefit to this. In any

case, it seems to prepare people for the transition from life to death.

As branching begins, we take with us a past, a memory of loved ones or of fear and loneliness, guilt and remorse, a world, a culture, a history of Being. So, we accumulate 'world' from a spooky excess, an after effect retrieved from an abyss as informational updates which does not distinguish sensuality from thinking. Neurology tells us all that this 'world' means is continually being neurologically torn down and rebuilt each time anew as recollective narratives of pain, sorrow, loss, love, a life. We branch from a collapse of history, language, and culture into a world with a past which flees from us as easily as we re-collect it.

The future is thrown from feeling-thought-projections together as a past, branching as such notions as choice, directions, reactions, desires, passions, ego, survival, thriving, all thrust forward as reaction to quantum collapse, a past and/or horizons not yet fully determined but determining. In a way the collapsing of the wave function and branching validates Leibniz' notion of the monad and all predicates residing in the subject. It also validates Hegel's basis for dialectical thinking as something that begins and ends in relation to the individual. Hegel brings back the essence of Descartes and Leibniz where thinking cannot be unthought and therefore must follow its consequences out to the immanence of Concept – we might just as easily call this the observer's collapse of the waveform or universal branching of sensual-information updates.

As we branch, we are sensual embodiment, we act, we range from conscious focus as choice to subconscious as unfocused but available historic narratives to unconsciousness which are not available to consciousness, we collapse together with worlds of our lived life. Waveform collapses not made entirely from scratch but made partially, unpredictably, and uncertainly from waveform accumulation as 'me' here now, from a one novel possibility we think as 'previous branching' together with infinite random and uncertain possibilities which upon branching set a finite value, e.g.,

as a particle, as ‘me’ here now. All of this mysteriously and spookily instantaneously without any such thing as prior and future. We have common histories in branching because my previous histories are simultaneously and novelly included as ‘all other possible outcomes’. But there is no memory-like effect of the previous branch. Memory implies a temporality i.e., previous, current, future. Whatever a second observation produces is still random and may or may not result in the ‘identically same’ previous value. There is some indication that there are various and probable ways that might retrieve a previous value. This feature is essential to quantum entanglement and makes it useful. This capacity is why we can have quantum computing. Some of these techniques involve preserving values classically such as ‘pure gates’ or helper gates, classical error correction techniques, parallel multidimensional matrixes of qubits, etc. But all of these mechanisms have something to do with branching into classicism. For example, pure gates involve potential and kinetic energy calculations. Energy is physical, not anything in the wave function.

As entangled systems in the wave function ourselves, we share branches, universes, with others. We also diverge or decohere from others in sensual-information branching. Existential angst as ‘me’ alone is pervasive because our sensual-informational words, our branching, is weighted together with our previous observation. We make choices, we validate or invalidate our feelings and informational assemblance and semblance of values, of memory. There is no opting out of this. There is no passivity where decisions, choices, and responsibilities are not made. There is no opting out, or fault, which absolves me of my choices and my unavoidable responsibilities from un-choose-able branching. We ‘think’ that we bring history, culture, language, love, hate, desire, fear all colored and entangled by us, with us, as choice, as judgement, as passion, as repulsion. We imagine in the freedom of choosing what we feel, what we think, what we need, in our incessant branching from the wave function. There is no classical exterior or macro world which

escapes branching from the spooky wave function. Classicism thinks in terms of epistemology and ontology. They are not simply that as if it were self-evident or innate. We are tales spun from spooky, abysmal no-thingness. These tales are narratives spun from an incalculable excess. In philosophy we call these narratives hermeneutics.

Hermes was the messenger from the world of humans to Hades, the underworld. He was the interpreter between mortals and gods or demigods. Hermeneutics is the study of narrative. History is a narrative just as the brain is neurologically built upon tearing down and rebuilding entangled neurons and pathways incessantly as a process of memory and mimesis. History is a tale we re-tell/tale ourselves, a new branch of information with every recollection. The history we need or crave is also what gives some of us severe and horrid pathological ways of thinking about humans. There is human evil. These people look in every way like humans but are capable of the most hideous, atrocious, diabolical deeds like the holocaust to other humans. These Frankenstein's of humanity have completely obliterated their responsibility, obligation, debt to anything other than themselves. If death is simply momentary superposition as Everett believed, the path toward the human demonic begins with the extreme retreat from responsibility narcissistically delighting in rage against every interminable branch of information which hints at any other.

From classicism, it seems reasonable that we take ourselves as here now from a personal past and a collective past. We are not reductively just information. What we take from our past also arrives with emotions, passions, judgements, recollections, tragedies. We project our desires, our futures from these previous narratives. Every branch of the wave function as me is taken up by narrative as a moment of decision for better or worse. In the freedom of our narratives, we make active choices or passively follow choices already made for us. In this freedom there is no postponing of choice. Choice is made either actively or passively.

Consequences follow in either case. What we have in common with anyone else is related to narratives in which freedom as our decisions in the world is determinate of our fate. Perhaps we call this karma or consequences but they both amount to the same.

Question 2:

There is no world, 'reality', or existence devoid of emotion, meaning, our lived and embodied experiences. There is no other realm where *phusis* no longer applies. History provides convenient mechanisms to elude and fantasize about some after death heaven which will make everything right for 'me' and take revenge on the errors of others in eternal Hell. All of these kinds of delusions rationalize and justify our own existence at the expense of others. Certainly, there is higher order transformation and emergence from quantum mechanics like chemistry, biology, psychology, geology, social science, etc. so I see no reason why the observer effect in the quantum wave function would exclude our lived experiences and conscious awareness.

Question 3:

This is an interesting question. I think it may involve a bit of metaphysics. Other branches of 'me' would be taken up by more complete information. For example, when one branch observes a dead cat in the box, another branch is initiated by another observer's observation of the original observer, and so on. The more information branches are accounted for in the wave function will result in more accurate probabilities of resulting states. The branches are not lost forever but become part of Laplace's demon or exformation. Perhaps the unconscious could be thought of as some kind of repository of other branches of 'me'. In this way, like Freud's mystic writing pad, there would still be a trace after the plastic is pulled on the surface of the pad as propensities, momentum, path, position, etc. which could function as pre-determinations, tendencies, consequences, a sort of karma map. As I already discussed, neurology has accumulated an amazing amount of information on agency and perception which makes

consciousness a small part of who we are and what constitutes experience. I could also see a value for responsibility for the Other (Autrui) as the 'others' of 'me' on other branches. On the flip side, self-absorption, narcissism, transactionalism, etc. would also implicate other branches of 'me'. I would think there would be a kind of middle-voice interaction between the conscious 'me' and the other unconscious-es or branches of 'me'. Certainly, other branches of 'me' do not come to the fore (for most of us ; -)) but in our conscious branch we see the Other (Autrui), we experience the Other (Autrui), we react to the Other (Autrui) with feelings, sensuality, etc. so responsibility to the exteriority of the Other (Autrui) could be what Levinas might refer to as ipseity. Ipseity means,

> "Minimal" self, also referred to as "basic" or "core" self or as "ipseity." This is a pre reflective, tacit level of selfhood. It refers to the implicit first-person quality of consciousness, ie, the implicit awareness that all experience articulates itself in first person perspective as "my" experience. In other words, all conscious acts are intrinsically self-conscious,7 a feature sometimes designated as "self-affection." "Minimal" or "core" self constitutes the foundational level of selfhood on which other levels of selfhood are built.[1552]

In the quote below Alphonso Lingis tells us, "of ipseity taking form as a relationship of immersion in the sensuous element, determining itself as pleasure or contentment." Additionally, the footnote above makes some interesting comments about pathologies like schizophrenia related to malformed ipseity. I also mentioned briefly earlier that the collapse of superposition can be malformed resulting in more uncertainty of results in the lab due to imprecise instruments. Of course, all of this is speculation bordering on some kind of metaphysical inquiry which I am sure would horrify many physicists. In any case, spooky exteriority as exformation is

certainly not metaphysical.

All along the way of wavefunction branching there is excess which eludes us. Those we love die. Every moment we decide in our life how we approach our own death and the death of those we love as yet another momentary superposition. At every branch there is choice as the observer effect. Is there 'other' which is not *worlds of my inheritance, creation, or origin*? Or are we collapsing into self-centric places where we are alone, shut off, in a world where the Other (Autrui) disappears into bitterness, anger, resentment, ego, despair? When we see psychotic killers and murderous tyrants, we see aberrations of humans who look human but resemble mechanisms, they seem to have absolute disregard for the Other (Autrui). Perhaps their branching has devolved into rage and vengeance for interminable, incessant, and ever branching yet again. Victor Frankenstein's horrific creation is himself not the 'creature'. What they bring to the fore is the question, what is human?

We face an exteriority in exformation which we cannot account for or even find a language to understand how it can be, its *isness*. What physics has brought to the fore if we pay attention is that an exteriority to all my branching is not yet another information update to substantiate 'me', a self, as if me as subject would resolve itself into a classical soul, spirit, the absolute upon which contingency would cease forever. Once we know that we do not know, we can open a line of inquiry as to how we face the Other (Autrui). The philosophical questions with a view to exformation, the characteristic trait of quantum physics, is a springboard for the next section where I want to look for repercussions of a different kind of exteriority regarding the Other (Autrui) and responsibility.

For Levinas, the Other (Autrui), the he or she, is a radical alterity which throughout our lives alludes us. The retreat from radical exteriority is effaced as Being, history, the world, which is not the Other (Autrui) but the ever-returning choice/collapse/observation of informational updates which guarantee a 'me' – the

echo of Being, only to ever after deliver yet another informational update in which the absolute ‘me’ never appears as promised. This retreat can never arrive at its destination, an enduring self, promised by classicism. However, instead of self-satiation, which can only hollow out its desire as yet another branch of my subjectivity, there remains an externality which faces my retreat as she or he which I cannot obtain or account for passionately or informationally. However, I can respond to undeniable responsibility through choice, deed, and action for the Other (Autrui). I can recognize that the Other (Autrui) is not in my own freedom as informational update. I can recognize branches which never return to the illusion of a universal ‘me’ but an exteriority that will never be my face or even have the capacity to take hold of, materialize as my fictitious presence or absence in idea.

Levinas calls retreat from the face and responsibility of the Other (Autrui) ‘subject’. Being, as my promised but never attained branching history, retreats from radical alterity into a façade of myself, what Levinas calls subjectivity. Being, ever eludes me in taking hold of me. Desires imagine they can supplant radical exteriority into ‘my’ own image, my informational update. My response or retreat already assumes responsibility beneath the freedom of choice. Even as ‘subjectivity’ branching information from the radical alterity of the wave function, observation and choice codetermine what is observed imagined as self-caused whether it be heroic or diabolic, indifferent or vengeful, prideful or resentful, jealous or angry – supplanting a semblance of me substituting as ‘the all’ without excess. This is pathology.

For Everett, in death perhaps returning to exformation as superposition we cannot die, only branch yet again from superposition where decision is already made in passive observation as thrown from history, language, and culture towards the ghastly narrative of the mythic ‘me to be’, where ‘reality’ is retreat from responsibility of the Other (Autrui), away from the imposition of radical alterity without ever succeeding. Levinas tells us the face of

the Other (Autrui) is the radical alterity history flees from and we obscure with our own face, our own history, endlessly deferring responsibility as my freedom, as the Other (Autrui) which is imagined in my providence, rule, and origin from my informational updates.

Let's look at how the repetitive past of informational updating has hollowed us out to the point where compassion much less human survival has become inconsequential to reactionary retreat into fantastical, self-satiated, delusions which never were. One thing, at least, I hope this section on physics has shown us is that what 'is', 'reality', stares us in the face as something which arises as spooky from our history, from the 'is' of us, of me, of religion, culture, and philosophy - a radical exteriority that throws 'me' as subject from the abyss of superposition towards a face, a face of an other which can never come from my ceaseless branching, my control, an exteriority I can never know completely or bring totally into my field of knowledge, and to whom I owe a debt which can never be paid, a responsibility I cannot avoid. From information to exformation to radical exteriority which calls me to decision is where the next section will take us. To prelude the section to come, here is a quote from the translator, Alphonso Lingis, of Levinas' later important work entitled "Otherwise Than Being or Beyond Essence".

> How far does responsibility extend? It is already in act. To elucidate responsibility is to bring to light a bond in which one is already held, and where there is still a demand to be answered. Responsibilities increase in the measure that they are taken up. They take form in an unendingly opening horizon, an infinition.
>
> That responsibility has the status of a fact means that it did not originate in an act of subjectivity — in the act of assuming or taking upon oneself. Temporally speaking, that means that responsibility did not originate through an act of

presentation or representation. Every representation already misses the originative moment. It does not only have the status of "always already there" when an act originates or begins, but the assembling of oneself and beginning which characterizes the act of consciousness will be shown to be launched from it. In this sense it is "pre-original," prior to all initiatives and their principles, an-archic.

This also means that I am not only answerable for what I initiated in a project or commitment of my will. I am responsible for the situation in which I find myself, and for the existence in which I find myself. To be responsible is always to have to answer for a situation that was in place before I came on the scene. Responsibility is a bond between my present and what came to pass before it. In it is effected a passive synthesis of time that precedes the time put together by retentions and protentions.

I am responsible for processes in which I find myself, and which have a momentum by which they go on beyond what I willed or what I can steer. Responsibility cannot be limited to the measure of what I was able to foresee and willed. In fact real action in the world is always action in which the devil has his part, in which the force of initiative has force only inasmuch as it espouses things that have a force of their own. I am responsible for processes that go beyond the limits of my foresight and intention, that carry on even when I am no longer adding my sustaining force to them — and even when I am no longer there. Serious responsibility recognizes itself to be responsible for the course of things beyond one's own death. My death will mark the limit of my force without limiting my responsibility.

There is in this sense an infinity that opens in responsibility, not as a given immensity of its horizons, but as the process by which its bounds do not cease to extend — an infinition of infinity. The bond with the alterity of the

other [*Autrui*] is in this infinity.

I am answerable before the other in his alterity — responsible before all the others for all the others. To be responsible before the other is to make of my subsistence the support of his order and his needs. His alterity commands and solicits, his approach contests and appeals; I am responsible before the other for the other. I am responsible before the other in his alterity, that is, not answerable for his empirical and mundane being only, but for the alterity of his initiatives, for the imperative appeal with which he addresses me. I am responsible for the responsible moves of another, for the very impact and trouble with which he approaches me. To be responsible before another is to answer to the appeal by which he approaches. It is to put oneself in his place, not to observe oneself from without, but to bear the burden of his existence and supply for its wants. I am responsible for the very faults of another, for his deeds and misdeeds. The condition of being hostage is an authentic figure of responsibility.

An ethical philosophy of responsibility grounded in a phenomenology of the face (or quasi-phenomenology: for a face is not so much a mode of appearing of the other, as a "trace" where alterity passes) has been the central concern of Levinas in Totality and Infinity and in subsequent writings that developed its theses, especially those assembled in Humanism and the Other. But Totality and Infinity was structured, classically, as a phenomenology in different strata, related as founding and founded. A sphere of pure sensibility was first disengaged, sphere of the nocturnal horror of the indeterminate, and of ipseity taking form as a relationship of immersion in the sensuous element, determining itself as pleasure or contentment. The relationship with things was carefully distinguished from this antecedent relationship of sensuous enjoyment and

> alimentation. It begins with inhabitation, the establishing of a dwelling, a zone of the intimate closed from the sphere of the alien. Things are apprehended as solid substances and movable goods, furnishings for a dwelling, before they are means and implements in a practical field. And there is a new form of ipseity identifying itself in these acts of inhabitation and appropriation, existence for oneself in the form of being at home with oneself, “être chez soi.” There was already a relationship with the other at this level, a relationship through cohabitation, with the other as complementary and “feminine” presence. But the relationship with the other in his alterity, the ethical relationship, breaks out in the face to face position in which language takes place. The ethical nature of the relationship with a face constituted the center and principle originality of Levinas’s analyses. But Levinas described also an erotic sphere, relationship with the carnal and with the child that comes in the carnal, relationship of voluptuousness and fecundity, as “beyond” the face, a sphere over and beyond the ethical. 1553

Quantum Consciousness

An article from Wikipedia entitled “Quantum mind” explains.

> The quantum mind or quantum consciousness is a group of hypotheses proposing that local physical laws and interactions from classical mechanics or connections between neurons alone cannot explain consciousness, positing instead that quantum-mechanical phenomena, such as entanglement and superposition that cause nonlocalized quantum effects, interacting in smaller features of the brain than cells, may play an important part in the brain's function and could explain critical aspects of consciousness. These scientific

hypotheses are as yet unvalidated, and they can overlap with quantum mysticism. [1554]

But regardless of the speculations of 'quantum mysticism' which even some of the greatest minds in quantum physics have vigorously advocated, serious research has gone on for over a hundred years and continues to this day. It is important to note that this remains a highly debated minority view in both neuroscience and physics.

The problem of how mind and matter are related to each other has many facets, and it can be approached from many different starting points. The historically leading disciplines in this respect are philosophy and psychology, which were later joined by behavioral science, cognitive science and neuroscience. In addition, the physics of complex systems and quantum physics have played stimulating roles in the discussion from their beginnings. [1555]

Here is a brief history of this research.

Eugene Wigner (1902-1995), a Nobel Prize winner in physics "*developed the idea that quantum mechanics has something to do with the workings of the mind. He proposed that the wave function collapses due to its interaction with consciousness".* [1556] Freeman Dyson (1923-2020) a well-known theoretical physicist argued that "*mind, as manifested by the capacity to make choices, is to some extent inherent in every electron*". [1557] David Bohm, one of the most significant physicists of the twentieth century "*believed that the brain, at the cellular level, works according to the mathematics of some quantum effects, and postulated that thought is distributed and non-localised just as quantum entities are. Bohm's main concern was with understanding the nature of reality in general and of*

consciousness in particular as a coherent whole, which according to Bohm is never static or complete." [1558] Niels Bohr (1885-1962), a very important pioneer of quantum physics who stated, "*Anyone who is not shocked by quantum theory has not understood it.*" [1559] Niels Bohr, one of the founding figures of modern quantum physics, proposed the concept of complementarity to understand atomic processes. He argued that this principle has parallels in psychology, biology, and social science, as well as in Buddhist and Taoist thought. The concept of complementarity was introduced by William James in 1891, and by physicist Niels Bohr in 1927, the latter probably without knowledge of the former. The phenomena were experienced as "gaps" in thought, and by the experiential observation that thought is divisible into transitive and substantive parts, providing evidence of complementarity. [1560]

Theoretical physicist Roger Penrose (1931-present), a Nobel Laureate in Physics and anesthesiologist Stuart Hameroff collaborated to produce the theory known as "orchestrated objective reduction" (Orch-OR). According to this theory, consciousness originates at the quantum level inside neurons, rather than the conventional view that it is a product of connections between neurons. The mechanism is held to be a quantum process called objective reduction that is orchestrated by cellular structures called microtubules. The hypothesis combines approaches from molecular biology, neuroscience, pharmacology, philosophy, quantum information theory, and quantum gravity. While mainstream theories assert that consciousness emerges as the complexity of the computations performed by cerebral neurons increases, Orch OR posits that consciousness is based on non-computable quantum processing performed by qubits formed collectively on cellular microtubules, a process significantly amplified in the neurons. The qubits are based on oscillating

> dipoles forming superposed resonance rings in helical pathways throughout lattices of microtubules. The oscillations are either electric, due to charge separation from London forces, or magnetic, due to electron spin —and possibly also due to nuclear spins (that can remain isolated for longer periods) that occur in gigahertz, megahertz and kilohertz frequency ranges. Orchestration refers to the hypothetical process by which connective proteins, such as microtubule-associated proteins (MAPs), influence or orchestrate qubit state reduction by modifying the spacetime-separation of their superimposed states. The latter is based on Penrose's objective-collapse theory for interpreting quantum mechanics, which postulates the existence of an objective threshold governing the collapse of quantum-states, related to the difference of the spacetime curvature of these states in the universe's fine-scale structure. See " Appendix A (alpha) – Quantum Consciousness References" for a long list of recent peer reviewed studies in this area. [1561]

Two areas are addressed in current research on quantum consciousness: 1) Quantum Brain, 2) Quantum Mind. Quantum brain focuses on neurophysiological levels of description. This includes single neurons, synapses, microtubules in the brain. John von Neumann (1903-1957) was a mathematician, physicist, computer scientist, engineer and polymath who is renowned and won many awards including having a crater on the moon named after him. His work tackled the question of the observer effect. Is the observer effect limited to consciousness or not?

> Neumann's fairly cautious stance, London and Bauer (1939) went further and proposed that it is indeed human consciousness which completes the quantum measurement process (see Jammer (1974, Sec. 11.3 or Shimony (1963) for a detailed account). In this way, they attributed a crucial role

> to consciousness in understanding quantum measurement in terms of an update of the observer's knowledge. In the 1960s, Wigner (1967) radicalized this proposal, by suggesting an impact of consciousness on the physical state of the measured system, not only an impact on observer knowledge. In order to describe measurement as a real dynamical process generating irreversible facts, Wigner called for some nonlinear modification to replace von Neumann's projection. [1562]

Umezawa [1563] (1924-1995), a physicist and recognized as one of the eminent quantum field theorists of his generation proposed a quantum theory of the brain which posits a spatially distributed charge formation exhibiting spontaneous breakdowns at micro levels as the basis for processing at macro levels. [1564] Many others have done research on how the brain relates to quantum physics, neurology, anatomy, and philosophy including Pribram [1565], Stapp [1566], and David Pierce [1567]. Another area that might lead to results of quantum brain could be Catecholaminergic Neuron Electron Transport. [1568] Additionally, the information flow between neurons in chemical synapses is initiated by the release of transmitters in the presynaptic terminal. This process is called exocytosis, and it is triggered by an arriving nerve impulse with some small probability. In order to describe the trigger mechanism in a statistical way, thermodynamics or quantum mechanics can be invoked. [1569] Another area of neurophysiology developed by Roger Penrose is stated below,

> In the scenario developed by Penrose and neurophysiologically augmented by Hameroff, quantum theory is claimed to be effective for consciousness, but the way this happens is quite sophisticated. It is argued that elementary acts of consciousness are non-algorithmic, i.e., non-computable, and they are neurophysiologically realized

as gravitation-induced reductions of coherent superposition states in microtubuli. [1570]

In summary, the terms "quantum brain" and "quantum mind" are often used interchangeably, but they refer to different concepts. The quantum mind hypothesis proposes that quantum-mechanical phenomena, such as entanglement and superposition, which cause nonlocalized quantum effects, may play an important part in the brain's function and could explain critical aspects of consciousness. On the other hand, quantum cognition uses the mathematical language of quantum probability to describe the way people make decisions, without assuming that the brain actually represents quantum states. Eugene Wigner developed the idea that quantum mechanics has something to do with the workings of the mind. He proposed that the wave function collapses due to its interaction with consciousness. However, contemporary physicists and philosophers have considered these arguments unconvincing. David Chalmers argues against quantum consciousness. He instead discusses how quantum mechanics may relate to dualistic consciousness. Chalmers is skeptical that any new physics can resolve the hard problem of consciousness.

The quantum mind hypothesis suggests that quantum-mechanical phenomena may play a role in the brain's function and consciousness, while quantum cognition uses the mathematical language of quantum probability to describe decision-making processes. [1571]

Quantum consciousness is not strictly the domain of flakes. Quantum physics has a long history of brilliant founders and researchers taking the topic very seriously. If you want to read a good .pdf on the topic, check out: Consciousness and the Collapse of the Wave Function (.pdf). There are also many more references in “Appendix A (alpha) – Quantum Consciousness References”. However, problems remain and while all this research demonstrates there are important problems which need to be addressed by

quantum physics' relationship to consciousness, the on-going science is still in the embryonic stage. While we know that quantum physics relates to our macroscopic world, the complexities of the wave function on these scales are still very difficult to address. It seems to me that a more practical approach with artificial intelligence and quantum computing may yield more timely solutions to quantum consciousness problems. [1572]

From the previous discussions it seems unavoidable that the most certain assumptions about our very being, 'reality', and even existence must be reexamined. I have no doubt that some will take all this as pure insanity. Foucault's book "Madness and Civilization" explores the symbiotic relationship between madness and unreason. This essential reliance on both binary dualisms must go underground psychologically and sociologically where both terms are rarely allowed to be shown as is the case that each depends necessarily on the other. Insanity and unreason are defined as "reason dazzled" or confused in the period of confinement. Centuries ago, the people deemed 'insane' were physically confined on a ship which remained at sea. This ship was called the "ship of fools". In the modern period, however, insanity and unreason are pushed further beneath the surface of society and is understandable only through certain artists (or contemporary political and religious/cult ideologies). Madness on the other hand, becomes mental illness, and is treated and controlled by medical and psychiatric practices. However, these sociological disassociations perpetuate destructive narratives and violence. A recent article writes,

> Some psychologists believe our values tend to cluster around certain poles, described as "intrinsic" and "extrinsic". People with a strong set of intrinsic values are inclined towards empathy, intimacy and self-acceptance. They tend to be open to challenge and change, interested in universal rights and equality, and protective of other people and the living world.

> People at the extrinsic end of the spectrum are more attracted to prestige, status, image, fame, power and wealth. They are strongly motivated by the prospect of individual reward and praise. They are more likely to objectify and exploit other people, to behave rudely and aggressively and to dismiss social and environmental impacts. They have little interest in cooperation or community. People with a strong set of extrinsic values are more likely to suffer from frustration, dissatisfaction, stress, anxiety, anger and compulsive behaviour. [1573]

It seems that as in Dante's allegory, the "Divine Comedy", history has brought us to the point where his journey through the afterlife in the Divine Comedy begins in the Inferno, where he is lost in a dark wood and on the way to damnation. Dante must go through hell and purgatory first before he finally reaches Paradise or Heaven. The mind inherited from histories of narratives has reached an abyss, quantum mind, where all seems bleak, reactionary, the mediocrity of Nietzsche's 'last man' without Nietzsche's blessed hope of the Übermensch, of self-ascendant affirmation at the expense of the ignoble. Instead, the quantum mind asks us to recognize exteriority which is not sealed within itself. An other which cannot be subsumed for the glorious One. The other of saying 'Yes' to the self's "will to power" turns out to be the Great Nausea of hell, Narcissus' echo.

Quantum Biology and Neurology

I do not know a lot about biology. But there is a lot of biological research which is taking quantum mechanics very seriously. I will do my best to elucidate some of this and give references for a more in-depth look.

For the casual observer biology seems to counter the spookiness of quanta, but does it? Koichiro Matsuno articulates the 'internalist

stance' of quantum biology which recognizes a superimposed linguistics of historically classical concept of internal biological *stasis* of static principles regarding cells, molecules, etc. which have an eerie relationship with the universal of classical physics.

> …it is a fundamental experience of molecular biology that living systems are distinguished from the surrounding inanimate matter by the exceedingly robust (stable), autonomous and highly efficient specificity of their internal quantum dynamics. In our sense, of macromolecular interactions (RNA/DNA → protein, protein enzyme → substrate), however, are not of ordinary chemical (quantum dynamical) specificity, they have quantum specificity of ordering one quantum state to another (say a single, locally determined global specific coordinate set (conformation) of the protein molecule singled out by RNA/DNA information, or enzyme action in general.
>
> Accordingly, in fact, conventional biochemistry (molecular biology) uses a highly classical language for the description of biochemical events. However, interactions being quantum dynamical, it is both embarrassing and hard to understand why this type of analysis is so efficient, as if the statistical laws of quantum theory were no longer valid (e.g., yielding byproducts or, in other words, producing other quantum states of product molecules). One solution, put forth first by Pattee, evokes quantum theoretical measurement processes, effective inside the biological system, between macromolecules acting on each other or on small molecule substrates, singling out a specific quantum state of the target molecule. 1574

How could we possibly think in terms of the 'observer effect' and biology? In physics the observer effect is thought in terms of measuring devices which cannot be separated from the wave

function. In biology the observer effect of the wave function is pushed into the corners of insignificance by the seemingly obvious categories of micro and macro events. But this convenient linguistics ignores certain processes already at work in biology. One example is the ways in which the genetic code is interrupted by statistically very improbable external influences which alter its unfolding anatomy in novel ways. In fashioning biological 'rules' we establish a symbolic control over biological processes which set up initial conditions. In other words, think of the butterfly effect in classical physics. We keep presupposing from our symbolic traditional rules that these rules control biological processes. Yet, we brush off into the corner what happens to the 'rules' when initial conditions become chaotically unruly. Instead of giving up any ground on our symbolic insistences we continue to appeal to a 'higher order' a 'macroscopic' classical unity. We preserve the 'internal' over and against the 'external'. Even Bohr, in his book "What is Life," has an assumption of this biological symbolic unity. Writing of W. A. Stern, Koichiro Matsuno tells us,

> with the observation that in physics the phenomenon is irreducibly coupled to the measurement apparatus (the experimental settings) in which it occurs. Similarly, in biology the phenomenon is irreducibly coupled to the controlling time-space ordered observational matrix superstructures, in which it occurs. Also, in physics the object/measuring apparatus interaction defies detailed analysis; similarly it is impossible to describe in detail the life process (the complementarity-irreducible problem of Bohr, in fact). Physical "event" and "life" are irreducible concepts in physics on one hand, and biology, on the other. However, he argued that biological internal measurement devices are not irreversible and macroscopic. Therefore, biological phenomena are objective, independent of our experimental settings.

> This is the conclusion of placing Bohr's general complementarity inside the system, defining ''objective'' (internal) measuring devices. Thus the shifted emphasis was on objective ''design of specific structures'' (macromolecules) with controlling (internal measurement) functions. In this way, the emphasis shifted to the specific, macromolecular structure that specify the internal measurement functions; however, the internal dynamics (their couplings in forming a novel order of matter), is in an internal complementarity relation to the controlling structure, corresponding to the object/apparatus irreducibility. 1575

It seems to me that what Matsuno is getting at is that there are no symbolic 'inner' and 'outer' classical linguistic rules which govern biological processes but rather a complementarity, like the wavicle. In this case the analogical 'particle' of biology would be the organism and the 'wave' of biological processes would be the 'wave'. The measurement device in biology is not an apparatus like a photon detector which makes 'objective' observation and quanta inseparable but "structures and processes *which generate unpredictability." His example is the enzyme molecule. Biochemical (metabolic) specific short-range quantum dynamics on one hand (in relation to the active center) and individuality of long-range dynamics of enzymatic (macromolecular) gross shape, charge, etc. and enzyme-enzyme long-range couplings as an active matrix on the other, are what together make practically possible the active existence of the active center and form the concerted reaction matrix that is unique and unpredictable.*" 1576

Just as classical physics language simultaneously explained and obscured biology has fallen into a similar semiotic which governs its syntax.

> In this way, Stern arrived at a structure-organization internal complementarity with the remarkable notion that in biology

> the overall, ultimately unresolvable, measurement dynamics, by a ”functional” (classical !) description, similar to the classical language, used in the quantum mechanics of the inanimate realm. 1577

But in its own terms as deconstruction in philosophy disclosed it must ever after find its explanations, its constitution, in the exhaustions of its own discord. So, biology is similar to physics, finding that there is an excess to its classical formulations which must address its lack of historic origin and deal with chaos as endemic.

> Stern’s greatest merit is that (naturally, in the spirit of the age), internalizing the physics/biology ”dichotomy”, as he pointed out the importance of the detailed quantum mechanical properties of the constituent molecules of living systems. The time was, in fact, the dawn of quantum biochemistry in the narrow sense. Quantum biochemistry, in this sense, within the usual theoretical chemical viewpoint, aims to derive the specific ”biological” attributes of ”living” matter, regarding them as derivable from specific interactions of specific molecules with specific quantum physical (theoretical chemical) properties. However, generally considering the problem, it reduced the scope of the investigations of the relation of physics and biology to a sub-branch of theoretical organic chemistry. Realizing this deficiency, general quantum biology, with its special historical problems, revived in the 70’s and 80’s and started to flourish again from the 80’s on. 1578

Matsuno’s complementarity has to do with recurrent boundary conditions ‘inside’ a biological system as quantum mechanical. This oddly reminds me a bit of the holographic principle which has two-dimensional boundary conditions which encodes three-dimensional

space volume. And let's not forget that this 2-D/3-D metaphor called holography can be extended into multiple dimensions where a boundary of one dimension less encodes volume. Could it be that biological boundary conditions refer to quantum mechanical processes? How would organic boundary conditions encode any kind of 'observer effect' which in an analogous way may become 'apparent' in what we think as space, volume, the environment? Matsuno's point of view is,

> If an external perturbation (cause) influences the open quantum system, it starts a sequential process where one reached microscopic object behaves as a boundary condition for the next one, the dynamical effect propagating with a finite velocity, at most with the velocity of light (according to special relativity theory). The perturbation thus causes a temporary microscopic "vacuum' of effects, the further constituents having an "expectation wavefunction", which collapses by the cause reaching them. This phenomenon, according to Matsuno, the origin of internal measurement (it was he who coined the term). The sequential collapses equilibrate the system, and restore globally the conservation of energy.
>
> Thus subsequent internal boundary conditions (of which initial conditions are only a special case) are inseparable from the internal quantum dynamics. Boundary conditions, well-known in Newtonian mechanics, are thus an integral part of the internal quantum dynamics. The "observers" are, in this way, internally specified and fused with the dynamics. 1579

One way this shows itself is in intercellular genetics and protein structures which are at work in evolution. Certain kinds of enzymes serve as memory states for genetic replication. They are built up from primordial RNAs. Primordial RNAs are RNA molecules that are

believed to have existed in the early stages of life on Earth before the evolution of DNA or proteins. According to the RNA world theory, the first RNAs were made using free-floating nucleotides that emerged in a primordial soup of molecules. They bonded together to make strands of RNA that weren't very stable and degraded quickly. But some were more stable than others; these RNAs grew longer and bonded nucleotides more quickly. Viroids, which are exogenous, autonomously replicating RNAs, are considered by some researchers to be "living fossils" of primordial RNAs. However, there is no unequivocal evidence for an ancient origin of viroids, but suggests, alternatively, that viroids may have evolved de novo more recently, probably by novel processes similar to those suggested by each reviewer. 1580

> In our case, accordingly, both the quantum mechanical measurement device as primordial protein polymerase enzymes (possibly ligases), also the record and memory states (actually, built-up primordial RNAs), together with the object system as primeval RNA oligomers, were macromolecular as is usual in conventional "internal measurement" cases. The protein device was supposedly internal (rather, an external boundary one, coupled to the internal network) to the protobiological system. The object RNA oligomers were, tentatively, external to it before the "measurement". By the measurement, supposedly, the measured object system as "record and memory" became similarly internal due to its coupling to the internally integrated macromolecular network of the measuring system. It was realized through coupling to the measurement device state of the proto-protein. These record and memory states, encoding the object/device (outcome) relations, must have been concomitantly mapped, presumably, onto the holistic internal causal dynamical network in a global way. This is required by the general processes in a molecular "mixed",

special endophysical ”self-measurement” (Ch. IV). The mappings define, as functions to functions operators, the assignations as quantum mechanically correlated and conserved outcomes of the special object/device (and record and memory) relations; hence we term them “assignation operators”. The necessary break in causality, rising in every ordinary, also in ”mixed” measurements (Section 4. 1. 1.) probably had a pay-off in a short period of chemical evolution in favor of a crucial degree of internal causality. This dynamical causality may have been followed from the past history of the molecular assignment process, the reversed macromolecular object/device relations, as the only causal time direction. It is eventually amounting to a space mapped regressive (real, positive time) time inversion symmetry restoring as its future. The process may have had a strong selection pressure against unavoidable destabilizing alternative fast ”decoherence” of uncontrolledly arising post-measurement time asymmetry, in favor of stabilizing causality. The process may have depended critically by internalization of the reverse causality, time flow. 1581

The “*primeval RNA oligomers*” were believed to grow on peptides which assembled nucleic acid polymers and lead to the first RNA strands. The RNA oligomers served as a classical “macromolecular” “internal measurement” case. But before that they were external to the process which led to the first RNA strands. As ‘external’ to the development of life it seems to me like what is being implied is a kind of spontaneous symmetry breaking which constitutes a ‘measurement’. In the measurement a “record of memory” is established. Interestingly, these short peptides were two dimensional. They are termed “selective amino acid- and nucleotide-matching oligopeptides” (SANMAOs). They bound with polymerized amino acids and were eventually dispersed into nucleotides. 1582 In a kind of spontaneous symmetry breaking the

“record of memory” becomes randomly altered by (rhizomic) branching. This is a chaotic quantum process. In a way I understand this as a broken mapping process which cannot be stitched together by the classical desire for continuity. However, what is interesting is that while arising from the branching of the observer effect of the ‘measurement process’ which in this case seems to be inherent to biological mapping each map, like fractals, without origin, arising from chaos, spontaneously emerges into a novel map.

On another front neurology seems to also be benefiting from quantum physics with quantum biology. Here is an interesting quote from quantum biology research,

> Exciting recent research shows that non-trivial quantum effects are present in biological systems – and not just in spite of, but sometimes because of, the interaction with the noisy and warm environment. Furthermore, because the brain is a complex non-linear system with high sensitivity to small fluctuations, it is likely that it can amplify microscopic quantum effects. Specifically, there are two alternative but interrelated ways in which quantum events may influence the activity of the brain:
>
> (1) Non-trivial quantum effects can speed up the computational processes in living organisms at the microscopic level.
>
> (2) Non-linear chaotic dynamics can amplify lowest-level quantum fluctuations upward, modulating even larger-scale mesoscopic and maybe also macroscopic neuronal activity.[1583]

Here is an abstract from three scientists at the UCLA Neuropsychiatric Clinic, Lawrence Berkeley National Laboratory, and Center for Research in Neurological Sciences,

> Neuropsychological research on the neural basis of behaviour

generally posits that brain mechanisms will ultimately suffice to explain all psychologically described phenomena. This assumption stems from the idea that the brain is made up entirely of material particles and fields, and that all causal mechanisms relevant to neuroscience can therefore be formulated solely in terms of properties of these elements. Thus, terms having intrinsic mentalistic and/or experiential content (e.g. 'feeling', 'knowing' and 'effort') are not included as primary causal factors. This theoretical restriction is motivated primarily by ideas about the natural world that have been known to be fundamentally incorrect for more than three-quarters of a century. Contemporary basic physical theory differs profoundly from classic physics on the important matter of how the consciousness of human agents enters into the structure of empirical phenomena. The new principles contradict the older idea that local mechanical processes alone can account for the structure of all observed empirical data. Contemporary physical theory brings directly and irreducibly into the overall causal structure certain psychologically described choices made by human agents about how they will act. This key development in basic physical theory is applicable to neuroscience, and it provides neuroscientists and psychologists with an alternative conceptual framework for describing neural processes. Indeed, owing to certain structural features of ion channels critical to synaptic function, contemporary physical theory must in principle be used when analysing human brain dynamics. The new framework, unlike its classic-physics-based predecessor, is erected directly upon, and is compatible with, the prevailing principles of physics. It is able to represent more adequately than classic concepts the neuroplastic mechanisms relevant to the growing number of empirical studies of the capacity of directed attention and mental effort to systematically alter brain function.[1584]

This article was written in 2005. Since then, neuroscience has had an interesting relationship with quantum mechanics. What was once called quantum neurobiology seems to have morphed into simply quantum biology. As was the case in the history of physics there is still a classical trend which believes quantum effects are unimportant in higher order biological functions. Two main reasons for this are:

- Quantum effects are cancelled out in the brain as macroscopic objects are oblivious to quantum effects.
- Quantum effects in the brain's neural networks have a noisy, wet and warm environment that cause decoherence of entangled particles very quickly and cancel out any trivial quantum effects. 1585

The end result of this is that in neurology there still is a belief that the brain "*should be thought of as a classical rather than quantum system.*"1586

But here is evidence which goes against the classic narrative of biology and the two objections listed above. I will leave out the extensive references to the research in this quote, but the footnote below can take you to those references. This is a rather long quote, but it seems fitting for this topic. Also, this quote brings up quantum coherence and decoherence which I have not written about yet but to put it simply for now, our bodies, our brain, are an entangled system. Quantum coherence refers to the ability of a quantum state to maintain its entanglement and superposition in the face of interactions and the effects of thermalization. Decoherence is the loss of exformation which 'leaks' into its environment. This is a rather long quote, but I think well worth the read,

> (1) Contrary to expectations, non-trivial quantum processes have been observed in living systems. Experiments provide

evidence for unexpectedly long-lasting quantum coherence in the electron transfer which is involved in photosynthesis. This quantum-mechanical process is thought to improve the efficiency of energy transfer in photopigment molecules. The pigment molecules seem to implement an efficient quantum algorithm to find the fastest route for the light-induced excitation of electrons. Quantum coherence has been found in photosynthetic bacteria as well as in marine algae. This suggests that evolution has been able to select and exploit quantum-mechanical features for fast and efficient computation in two evolutionary distinct organisms. Another example of quantum dynamics in living systems has been found in photoreceptors, which are important for vision. Photoreceptor cells of the retina contain a protein called rhodopsin. Experiments using high-resolution spectroscopic and nuclear-magnetic resonance techniques revealed coherent quantum waves in the rhodopsin molecule. As summarized by Werner Loewenstein: “Quantum mechanics, not classical mechanics, rules the roost at this sensory outpost of the brain”.

Quantum effects have been described also in the olfactory system. Electron tunneling has been suggested to play an important role in the detection of odorants by olfactory receptors. Avian magnetoreception is yet another example of potentially beneficial quantum effects in biology. Long-lived quantum entanglements in the cryptochromes of the retina seem to support the sensitivity of a bird’s eye to magnetic fields. Recent simulations show that quantum mechanical coherences in cryptochrome models can account for the precision of the avian magnetic compass. In addition, quantum tunneling has been observed in other biomolecules, such as enzymes or motor proteins. Most importantly, contrary to the long-held view, under some conditions, the strong coupling to the noisy and warm environment is able

to promote rather than hinder long-lasting quantum coherence in biological systems. Because of the accumulating evidence that quantum phenomena need to be considered explicitly and in detail when studying living organisms, quantum biology has recently emerged as a new field at the border between quantum physics and the life sciences.

“Physicists thought the bustle of living cells would blot out quantum phenomena. Now they find that cells can nurture these phenomena—and exploit them”.

So far, we have focused on non-trivial quantum processes in sensory cells. But are non-trivial quantum effects also present elsewhere in the nervous system? It is very likely, but direct experimental evidence is still missing. Where should we look for further instances of neuronal quantum effects? There are many stochastic neuronal mechanisms, which may be driven by quantum events. Although it is true that “the main sources of neural noise are forces that can be characterized as thermal and chaotic rather than quantum in nature”, quantum physics is expected to shape at least some stochastic events in the brain, such as the opening of ion channels. In this way microscopic quantum events might affect electrical signals in neurons, as proposed by Paul Glimcher:

“[T]hese data suggest that membrane voltage is the product of interactions at the atomic level, many of which are governed by quantum physics and thus are truly indeterminate events. Because of the tiny scale at which these processes operate, interactions between action potentials and transmitter release as well as interactions between transmitter molecules and post-synaptic receptors may be, and indeed seem likely to be, fundamentally indeterminate”.

Johnjoe McFadden has made a similar suggestion:

“If neurons poised on the dynamics of individual

membrane proteins are critical to the initiation of a particular course of motor action or cognitive process, then the consequent action or cognitive processes will be subject to non- deterministic quantum dynamics".

It is in itself important that quantum coherence in living organisms has been experimentally demonstrated at the microscopic level. But what are the spatial and temporal limits of these quantum effects? Can we discover quantum coherence in more than just a few molecules? How long can it persist? Some quantum brain proposals, focusing on explaining consciousness, would require coherent quantum waves on much larger and longer scales than those found so far. The honest reaction to the questions just posed is that we do not know the answers to them and that only future research can provide those answers. The 'orchestrated objective reduction' (Orch-OR) hypothesis based on putative quantum computations in microtubules has been criticized for various reasons, e.g., for not being able to distinguish between neural mechanisms of conscious and unconscious information processing. Although the authors of the Orch-OR model have tried to address most of the criticisms, their and other quantum consciousness hypotheses remain controversial and difficult to test experimentally. Interestingly, a new quantum cognition model, based on entangled calcium phosphate molecules in neurons, has recently been suggested and seems better testable than previous proposals. One might speculate that future research on quantum cognition and consciousness might benefit from developing a quantum version of the integrated information theory. Nevertheless, it is very important to emphasize that the main idea of this article, namely that biological evolution is able to take advantage of non-trivial quantum events at the microscopic level (see above) and even at larger-scale levels [by non-linear amplification, see point (2) below], is not

dependent on the plausibility or validity of quantum consciousness proposals.

(2) If it turned out that quantum effects cannot be observed in living systems at the macroscopic level, would that mean that living systems can be fully described by classical physics? Or is there another plausible way in which small-scale quantum effects – there is evidence for their occurrence [see (1)] – might influence large-scale neuronal activity and behavior? Yes, there is. The common view that minuscule fluctuations, including quantum events, cancel out in larger systems need not be true in highly non-linear systems like our brain. The nervous system can be seen as a nested hierarchy of non-linear complex networks of molecules, cells, microcircuits, and brain regions. In iterative hierarchies with non-linear dynamics (at the edge of chaos), small (even infinitesimal) fluctuations are not averaged out, but can be amplified. Quantum fluctuations on the lowest level of scale may influence the initial state of the next level of scale, while the higher levels shape the boundary conditions of the lower ones. This hierarchy of nested networks with many feedback loops exploits rather than cancels out the quantum effects as proposed by Jeffrey Satinover:

"[Q]quantum dynamics alters the final outcomes of computation at all levels – not by producing classically impossible solutions but by having a profound effect on which of many possible solutions are actually selected".

In his essay on free will and neuroscience, Haim Sompolinsky has also mentioned this possibility:

"Chaos within the brain may amplify enormously the small quantum fluctuations … to a degree that will affect the timing of spikes in neurons".

Similarly, even Christof Koch, one of the major critics of quantum brain ideas, had to admit:

“What cannot be ruled out is that tiny quantum fluctuations deep in the brain are amplified by deterministic chaos and will ultimately lead to behavioral choices” (Koch, 2009).

The quantum amplification mechanism has been adopted also by Scott Aaronson whose recent “freebit” theory of free will “postulates that chaotic dynamics in the brain can have the effect of amplifying freebits to macroscopic scale”. A similar theory has already been proposed by Jordan (1938).

What is the evidence for the proposal that the brain is a complex non-linear system, capable of chaotic dynamics? Experimental evidence shows that neuronal networks can produce complex patterns of collective activity, which are called neuronal avalanches. These avalanches have a characteristic distribution: each avalanche engages a variable number of neurons, but, on average, many more small avalanches are observed than large ones. This indicates that neuronal networks are poised near criticality and are prone to displaying emergent complex activity. Similar results supporting criticality in the brain have been obtained on a larger spatial scale from fMRI data and from local field potential and spike recordings. In general, we can observe three types of dynamics in the brain: (1) ordered/subcritical dynamics consisting of oscillatory synchronous activity with the characteristic features of high coordination and low variability, (2) random/supracritical dynamics consisting of asynchronous irregular activity with low coordination and high variability, and (3) complex/critical dynamics with high coordination and high variability. Brain states exhibiting complex/critical dynamics are the most interesting ones because they support the most efficient information processing. At the critical point between order and disorder (i.e., at the edge of chaos and instability), neurons can communicate best, since at that point they are coordinated

but not stuck in a certain state for a long time and can establish long-range dynamical correlations. Furthermore, neuronal networks in near critical states display, because of largest fluctuations, the largest repertoire of network activity. Finally, at the critical point, the highest sensitivity to small fluctuations is observed: even a single neuron perturbation has a small but non-zero chance to trigger an avalanche. As pointed out by Dante Chialvo, there are convincing Darwinian reasons for supposing that (parts of) our brains operate near the critical point: in a subcritical world, everything would always be uniform, there would be nothing new to learn and hence no critical and plastic brain would be needed; memories might as well be unchanging. In a supracritical world, everything would always be changing with no regularities to be learnt. No long-term plasticity and memory would be of any help. In our critical (complex) world, surprising events do occur, but regularities, too, are present so that the brain needs to register but also to update the stored memories.

"[B]rains seem "balanced on a knife-edge" between order and chaos: were they as orderly as a pendulum, they couldn't support interesting behavior; were they as chaotic as the weather, they couldn't support rationality".

Thus, it is plausible, that small quantum fluctuations can be amplified, since brain activity can develop to the critical point: the point of complex neuronal dynamics. Interestingly, recent calculations suggest that quantum coherence can become long-lived in complex systems which are in a critical state between chaos and regularity – at the edge of quantum chaos.

In summary, the intricate interplay between quantum effects and non-linear complex dynamics might be able (a) to generate new persistent quantum-chaotic patterns at a microscopic scale, (b) to amplify quantum effects to a

> macroscopic scale. How exactly the indeterminacy of complex quantum dynamics of the brain is embedded in classical neuronal mechanisms of decision making remains to be determined.[1587]

Thematically we can say that complementarity lets opposites stand without resolve. Why? Because uncertainty, chaos, has an inextricable link to observation, every entangled system feeds into incalculably[1588] other entangled systems, which induces 'noise', information not yet compiled as order, cause and effect. This is the basis of emergence which will be discussed later. Entanglement will be discussed more at the end of this discussion on complementarity.

A Deeper Dive – The Beginnings of Life?

A new research paper has found random mutations of something called microRNA (miRNA). MicroRNAs are fascinating little molecules that play a significant role in gene regulation. What Are They?

MicroRNAs are small, single-stranded, non-coding RNA molecules. They typically contain 21 to 23 nucleotides. These tiny RNA molecules are found in plants, animals, and some viruses. Their primary function lies in RNA silencing and post-transcriptional regulation of gene expression. How Do They Work? MicroRNAs base-pair with complementary sequences in mRNA which are microRNA molecules. Once paired, they can silence the target mRNA in several ways:

- Cleavage of mRNA: They can cut the mRNA strand into two pieces.
- Destabilization of mRNA: By shortening its poly(A) tail.
- Translation Inhibition: Although this method is the least efficient, it requires the aid of ribosomes. [1589]

Think of microRNA as tiny RNA detectives, ensuring that specific genes are expressed at the right time and in the right amounts.

MicroRNAs are similar to ‘Small Interfering RNAs’ (siRNAs):

- miRNAs resemble siRNAs from the RNA interference (RNAi) pathway.
- However, there’s a subtle difference: miRNAs derive from regions of RNA transcripts that fold back on themselves to form short hairpins, while siRNAs come from longer regions of double-stranded RNA. 1590

The human genome may encode over 1900 miRNAs, although more recent analysis suggests that the number is closer to 2300. Approximately 500 human microRNAs are bona fide miRNAs in the manually curated miRNA gene database. These molecules are abundant in many mammalian cell types and even circulate extracellularly in body fluids like blood and cerebrospinal fluid. Their potential as biomarkers in various diseases is being explored.

The first miRNA was discovered in the early 1990s, but they weren’t recognized as a distinct class of biological regulators until the early 2000s. MiRNA research has revealed different sets of miRNAs expressed in various cell types and tissues, impacting plant and animal development and other biological processes. Aberrant miRNA expression is implicated in disease states, and miRNA-based therapies are under investigation. These tiny RNA molecules wield significant influence over gene expression, orchestrating a symphony of molecular interactions within our cells. From the study,

> The emergence of novel genes from previously nonfunctional sequence has gained significant attention, but the mechanisms behind this process have remained elusive. MicroRNA (miRNA) genes are one of the simplest forms of

genetic information and their transcripts fold into a short stem-loop structure to yield

22-nt gene products that suppress mRNA targets. While some miRNA genes are ancient, new genes also appear to emerge de novo [new, novel]. Here, we show that template switching in DNA replication can form perfect base pairing for a stem structure with a single mutation event and has participated in the emergence of nearly 20 human miRNA genes. Being a relatively high-frequency mechanism, template switching provides raw material for evolution and allows for near-instant rewiring of genetic information and rapid adaptation to changing environments. 1591

Interestingly enough, the human genome is a sequence of 20,000 genes. These genes create and regulate life-sustaining proteins. The genes that regulate and manage these sequences are palindromic. This means the entire code can be read forward and backward and they have the same sequence. Even for microRNA the chances of random mutations causing them to be palindromic is extremely small. But using a computer model the researchers compared species without microRNA and species with microRNA to reveal how one random, single mutation event could produce the whole human genome sequence we see today. 1592

Some of the legitimate areas of research for physics can be found in biophysics. Biophysics is a vast area of research which approaches biology from a physics perspective. It utilizes classic physics and quantum physics. Here are some further areas which have been affected by quantum physics.

Biophysics is an interdisciplinary science that applies approaches and methods traditionally used in physics to study biological phenomena. Biophysics covers all scales of biological organization, from molecular to organismic and populations. Biophysical

> research shares significant overlap with biochemistry, molecular biology, physical chemistry, physiology, nanotechnology, bioengineering, computational biology, biomechanics, developmental biology and systems biology. 1593

One interesting area of research is quantum biology. Quantum physics has already proven its effect reaches into the atomic and molecular level.

It seems to me this is a case where, in the limit of quantum complexity, something 'randomly' emerged which was novel. Could we think of this as due to new degrees of freedom in quanta? Certainly, this would not have been possible in the physics of the early universe. The notion of complexity, which is not classical, due to initial conditions, but something emergent from quantum chaos, new degrees of freedom, certainly seems to indicate something like spontaneous symmetry breaking or something like the observer effect arising spontaneously from the quantum wave function's state reduction which cannot be 'accounted for' in terms of classical chaos theory.

Curing Cancer

Quantum computing will solve complex biological problems, including the prediction of protein structures and understanding disease mechanisms. Here's how quantum computing will tackle the challenges posed by constantly mutating proteins and their implications for cancer. Predicting quickly mutating proteins and when they go wrong resulting in cancer is a problem made for quantum computing due to its immense computational abilities. Traditionally, researchers have used classical computational methods to predict protein structures. These methods rely on training data from experimentally determined protein structures. However, these classical approaches face limitations. When

encountering mutated proteins (common in genetic disorders), their accuracy decreases because they were trained on specific protein variants. Quantum computing, in combination with classical methods, can overcome these limitations. Quantum algorithms can address areas that challenge classical computers, such as protein size, intrinsic disorder, and mutations. [1594] The immense complexity of these mutations is because proteins are continually folding over on each other and radically changing themselves. Simulating the physics of protein folding is essential for drug design. However, classical computers struggle with large proteins due to the immense computational complexity. Quantum computers can explore multiple protein conformations simultaneously, thanks to superposition and entanglement. This allows them to efficiently search for stable protein shapes, even for larger molecules. Researchers have already validated this approach by accurately predicting the folding of a small fragment of a Zika virus protein using a quantum computer. [1595] Quantum computing will allow real-time diagnosis and treatment of cancer. Quantum technologies can accelerate the processing of quantum sensor data. For instance, nuclear magnetic resonance with specific quantum sensors can detect single molecules and cells, revealing membrane protein structures relevant to cancer. [1596] Real-time diagnosis based on quantum sensor data could revolutionize cancer treatment by providing precise insights into protein interactions and disease pathways.

Entangling Observations About ChatGPT 4 and Us

In this section I want to show something about artificial intelligence which does not reflect so much on artificial intelligence as it does on us. I wanted to know what ChatGPT 4 would tell me about entanglement on macro scales and/or warm and/or moist environments like biology. Below are the answers and references as well.

1. **Are there any entangled particles in the human body?**

Quantum entanglement is a phenomenon that occurs at the subatomic level, where two particles can become entangled and remain connected even when separated by vast distances. While it is theoretically possible for entangled particles to exist in the human body, there is no scientific evidence to support this claim. The phenomenon of entanglement is thought to take place throughout nature, among the atoms and molecules in living species and within metals and other materials. However, it is important to note that the scale at which entanglement occurs is much smaller than the scale of the human body. Therefore, it is unlikely that entangled particles exist in the human body. [1597]

What Is Entanglement and Why Is It Important?

If You Know Things Before They Happen, You Have This Magical Brain Quirk

How Your DNA Could Really Be Entangled in the 'Genetic Internet'

Microplastics are in our bodies. How much do they harm us?

1. **Can entanglement happen on a macro scale?**

Yes, quantum entanglement can happen on a macro scale. In fact, in a 2021 study, quantum entanglement was directly observed and recorded at the macroscopic scale - a scale much bigger than the subatomic particles normally associated with entanglement. The experiment involved two tiny aluminum drums one-fifth the width of a human hair, which were kept in a synchronized state in terms of their position and velocities. While the dimensions involved are still very small from our perspective, they are absolutely huge in the realm of quantum physics.

Quantum Entanglement Has Now Been Directly Observed at The Macroscopic Scale

Quantum Entanglement Has Been Directly Observed on a Macroscopic Scale

Quantum Entanglement Has Now Been Directly Observed at a Larger Macroscopic Scale

1. **Can quantum entanglement happen at room temperatures?**

Yes, quantum entanglement can happen at room temperature. Researchers have successfully produced macro-scale quantum entanglement at room temperature through the one-two combo of an infrared laser and electromagnetic pulses. In fact, a recent study has shown that ponderomotive entanglement generation in a movable-end-mirror-type optomechanical cavity can be achieved at room temperature and in a small magnetic field. This work will play an important role in the development of ponderomotive entanglement devices. 1598

Macroscopic quantum entanglement achieved at room temperature

Optomechanical entanglement at room temperature: A simulation study with realistic conditions

First Macroscopic Quantum Entanglement Performed At Room Temperature

Matson, John. December 1, 2011. “Quantum Entanglement Links 2 Diamonds”. Scientific American (online)

1. **Can quantum entanglement happen in warm or moist environments?**

According to a recent study by researchers at the ICFO in

Barcelona, Spain, entanglement-based quantum technologies, which were previously thought to function only in cold, low-noise conditions, may work in "hot and messy" environments too. The study suggests that entanglement is large where the interaction between particles is strong, and the temperature of the environment does not seem to affect the entanglement.

However, it is important to note that the study was conducted in a controlled laboratory environment, and the results may not be directly applicable to all real-world scenarios. Further research is needed to determine the extent to which entanglement can occur in warm or moist environments. 1599

Quantum entanglement (Wikipedia)

Entanglement gets hot and messy

Quantum tool opens door to uncharted phenomena

15 trillion quantum entangled atoms make a record-breaking hot mess

1. **Do physicists believe that entanglement happens in biological animals or plants?**

Physicists have been studying the phenomenon of quantum entanglement in biological systems, including animals and plants. In fact, researchers at the Lawrence Berkeley National Laboratory and the University of California, Berkeley have observed and characterized entanglement in a real biological system for the first time. They found that entanglement is a natural feature of quantum mechanical effects in photosynthesis, which is the process by which green plants convert sunlight into electrochemical energy with near 100-percent efficiency.

In another study, physicists have suggested that entanglement could be occurring in the photosynthetic complexes of plants, particularly in the pigment molecules,

or chromophores.

While there is still much to learn about the role of entanglement in biological systems, these studies suggest that it may play a critical role in the transfer of energy in photosynthesis. 1600

Untangling the quantum entanglement behind photosynthesis

Quantum entanglement in photosynthesis and evolution

Entangling Biological Systems

Chronobiology Meets Quantum Biology: A New Paradigm Overlooking the Horizon?

Below I have detailed the contrasting and even contradictory quotes from the questions above.

Pros

The phenomenon of entanglement is thought to take place throughout nature, among the atoms and **molecules** in living species and within metals and other materials.

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> (1.) However, it is important to note that the scale at which entanglement occurs is much smaller than the scale of the human body. Therefore, it is unlikely that entangled particles exist in the human body. However, it is important to note that the study was conducted in a controlled laboratory environment, and the results may not be directly applicable to all real-world scenarios. Further research is needed to determine the extent to which entanglement can occur in warm or moist environments. 1602

Even in its infant debut ChatGPT 4 captures us more than it captures our classical notions of 'intelligence'. Chat GPT-4 reflects our more repressed violations of logical consistencies. I believe more and more artificial intelligence will be a great resource for a kind of psychoanalysis of ourselves. I think many folks would look at this and sigh thinking artificial intelligence is not there yet. Artificial intelligence should not be thought of as more intelligent than us in many cases, especially at the current time. However, I think artificial intelligence should be looked at as a kind of contemporary archeology of us at the present time. And hidden in that 'archeology' also conceals an intuition about our future. The dominant classical, progressive narrative portrays progress as less contradictory and more simplistic in terms of accuracy taken up by the term symmetry. Patterns and repetition are pre-understood as 'more true'. However, a more submerged narrative is that our history of scientific discovery has become more complex over time.

The quantum wave function has a hazy relationship with biology, existence, determinate infinitesimals and binary truths. Complexity does not simply arise into either-or or both-and in terms

of their determinations but from in-determinability which falls, branches, collapses in a spooky singularity of the observer effect. If the quantum wave function can be constrained significantly enough it can give us probable results which nevertheless cannot ever be sufficiently isolated, infinitesimal-lized, to prevent completely chaotic behavior. This I refer to as radical exteriority. Complexity does not reach a limit in infinitesimals but passes into quantum chaos theory which has some indefinite relationship to emergence and novelty. But novelty here denies any such thing as 'completion', as *telos*. Neither does the classical hope of *telos* offer any hope to the *sublime* left to come, a beyond or more originary origin to *telos.* The quantum wave function may be sufficiently isolated from the environment to give us useful information, but it cannot be thought of in terms of completion or *telos*. The inability of the universal[1603] wave function to recognize such notions of chaos becoming ever more infinitesimally ordered is obliterated by the 'bath' of the most unconventional and unclassical 'environment' . The quantum wave function is the simultaneity of chaos which exceeds beyond any measure ever more sublime infinitesimals. The wave function has no regard to spacetime, order, as if some novel order could be differentiated and transformationally positioned with other classical orders. The spooky observer effect does not establish unities, orders, or truth behind the scenes of existence. The classical notion which demands teleology is incapable of finding ground and certainty in determinations.

More complexity over time has not led us to 'universal truths' but instead has led 'universal truths' towards more subtleties. For example, absolute time and space has been eaten away by the findings of quantum physics and even strongly hinted at from the impossibility of Einstein's mathematical anomaly – the singularity. The more intensely we scrutinize externality, *phusis*, the less we find easy answers and the more the desperations of our dominant classical narratives get taken towards more subtleties. To its credit quantum field theory has made amazing progress towards giving a

quantum contextual frame to relativity, Einstein's theory of spacetime. However, more and more it seems that spacetime is a limited case of something much more fundamental which erodes the hope of universal symmetry and signals the end of the fanaticisms of facing the gaping abyss of ever more sublime classicisms. The direction of intelligence does not seem to be towards more simplicity but towards more complexity. And complexity does not move towards more subtle infinities as in classical chaos theory but towards quantum chaos theory. The classical emotive drive towards classical notions of sublime beauty, symmetry, underlying/overlapping Platonic Forms which usher in transformations of essence towards ever more transcendental *telos-es*, truer completions and fulfillments, are punctured irrevocably by quanta, irreconcilable discrete levels which radically puncture continuation, harmony, essence. It seems that classicism's emotive drive towards symmetry in complexity moves forcefully towards the ever more sublime and the infinitesimal. Through the centuries this faith has led us more and more towards the self increasingly facing impoverishment, alienation, and mediocrity from exasperated objectivity. Nietzsche's final cure is superman, the comic book version of classicism gone wild.

Classical chaos theory and quantum chaos theory both have very different orientations to emergence and novelty. Interestingly as previously discussed, classical chaos theory can find *semiclassical* relationships to quantum chaos theory. Classical chaos theory vanishes at the limit of quantum chaos. The correspondence principle states that classical mechanics emerges as the classical limit of quantum mechanics when the ratio of Planck's constant to the action of the system approaches zero. There is a radical disjuncture where classical chaos finds its spacetime limit and where quantum chaos no longer recognizes ever increasing infinitesimals. Here are some differences in how these two areas of research are studied. 1604

- Perturbation theory seeks to perturb quantum systems with increasingly highly controlled exposure to the 'quantum bath', increasingly exposing a highly isolated quantum experiment to the quantum environment to determine how the wave function moves toward decoherence. This approach tends towards smaller quantum numbers. Perturbation theory cannot approach incrementally quantum chaos. Therefore, it is not as useful for research in quantum chaos. Quantum chaos research wants to understand how the quantum wave function moves towards large, macro level numbers. Quantum chaos does not exclude larger patterns and may well find answers well into the future about macro level phenomenon like biology and evolution. Quantum chaos may well occur macroscopically without any possible recourse to any theory of causality, origin, or classical sublimes exceeding them and prohibiting recourse to any kind of incremental approach as in perturbation theory.
- Chaos theory looks for ways to correlate random statistical descriptions of energy levels in eigenvalues (pure states) which are artificially contrived in the lab to reflect more well-known classical behavior in Hamilton mathematics.
- Chaos theory investigates low energy level, thermodynamic energy 'scars' in pure eigenstates. Scars are chaotic deformations found on eigenstates which are unusual and 'stick out' at times with specific and random patterns and structures. Ergodicity refers to the idea that a quantum system explores all its available thermodynamic states over time. But scars break the ergodicity rule weakly and can actually lead to robust oscillatory dynamics. Semiclassically this is related to thermodynamics.
- Oscillatory dynamics can be investigated spectrally.

> Classical chaos uses spectroscopy or how light interacts with matter to discover semiclassical behavior which simply ceases to exist at the limit where quantum chaos destroys any hope of infinitesimal symmetries. 1605

Here is a very important point - due to the odd but vast difference between classical chaos theory and quantum chaos theory important notions having to do with emergence and novelty are extremely different in each theory but as previously discussed do find *semiclassical* relationships. The importance of these differences weighs heavily on future determinations of how macro-level systems are related to entanglement in the quantum wave function. As I previously discussed, intuition from the earliest ancient Greeks touched on the notions of quantum chaos and its relationship to what we think of as emergence and novelty, but it subsequently lapsed into religious and metaphysical histories which sought to uphold origin, rule, and authority.

Novelty is not some kind of divine mythos. Anarchically, the wave function can be sufficiently isolated to provide very strange observer effect yes and no answers as was previously discussed. This likely formed the basis of classical determinations. However, the quantum wave function is radically exterior to classicism in that on one hand it vehemently resists language, history, and narrative and on the other hand collapses or branches in the very weird singularity of the observer effect – into classicism's narratives and classical chaos theory and the ever-looking towards more complex and subtle error conditions in infinitesimals (the butterfly effect). In a hazy fashion branching as observer effect leads to all such narrations of essence, reality, and truth. Even the ancient scientists first discovered this as 'error'. All the while the quantum wave function collapses from an unbridgeable abyss of uncertainty, randomness, and probability. The closer we look at error does not lead to more contingent certainties but loses itself to irrecoverable chaos. Emergence and novelty taken from quantum chaos theory

immeasurably exceeds classical chaos theory's notions of 'emergence and novelty' in the extreme difference shown as ever more awkward ontological or epistemological based answers.

Quantum chaos has already shown us that classicism does not end in ever more infinitesimal initial values but in quantum chaos - without causality, without origin, anarchically. Pure quantum chaos on the universal[1606] wave function scale leaves classical complexities which could potentially be manageable behind. However, the very weird idea is that pure quantum chaos underlies all our relatively simplistic observer effects which make all classicisms and binary dualisms possible. Plus, the very odd kind of singularity in the observer effect is not bound to typical categories of thinking the self, subjectivity, etc. as fundamental or even purely contingent. We live and move and have our Being as oddly emergent from spooky simultaneity, entangled and entangling, as the quantum wave function - not as mechanism as the metaphysical modernists assume. More fundamentally, biology desires to conceive of continuous, smooth infinites and infinitesimal, higher order transitions. Instead, budding quantum biology has an unaccounted-for externality which resists intuition, mythologies, narratives of historic necessities. Even more odd, the haunting idea that we are life. More on all this later. For now, I want to examine one particular instance of very recent attempts to examine biology, in a classically novel and very sublime and interesting trend, Hegelian philosophy and biology. I admit this is a particular weakness of mine but may well wane as highly technical and difficult without more background than I can provide now.

A Deeper Dive – Biology, Concept, Hegel, and Quantum Chaos

At this point I want to delve into some current philosophical approaches to biology in the Hegelian school to illustrate some of the most current approaches to biology and how they might relate to the current discussion.

Dr. Wendell Kisner in his book “Ecological Ethics and Living Subjectivity in Hegel's Logic: The Middle Voice of Autopoietic Life” (Kisner, 2014) undertakes a Hegelian approach to the concept of biology and life. In his critique of a paper by Humberto Maturana entitled “Biology of Cognition” 1607 Kisner, writing of this paper, tells us Maturana has two instructive points to tell us,

1. at the very least it shows that thinking of non-human living systems as being in some sense “cognitive” is not foreign to theoretical biology; and
2. it can also reveal the pitfalls of neglecting a proper philosophical articulation of concepts at the ontological level insofar as, due to this neglect, Maturana winds up falling precisely into the trap Hegel warns us about by assuming a quasi-Kantian distinction between what things are in themselves as opposed to what they are for us as “observers.” 1608

The first point tells us that theoretical biology need not prohibit a novel notion of cognition to non-human living systems. The second point addresses Kant’s oppositional idea of the ‘thing-in-itself’ which necessarily implies a binary duality to how phenomena must be made to appear to us as ‘observers’. Hegel’s approach is not to set up Kant’s irresolvable opposition to things in themselves with us as passive ‘observers’ but in essence to get back to Leibniz’ idea that all predicates reside in the subject. In other words, ‘concept’ is not some exclusive domain that is essentially different from phenomena but in the most technical sense of the word ***is*** phenomenon. Concepts *are* ontological and even biological. Life, human or not, simply *conceptualizes* meaning, for example, as a higher organizational structure than what we think of classically as pure ‘biological science’. Cognition implicitly “*is not foreign to theoretical biology*”. For Hegel, biological life organically rises up into Concept. The implications of this directly affect the idea of

‘self’ and the other.

In using the term ‘self’ I am not referring to common conceptions of the self but to a more sublime concept stated in the word autopoiesis (from Greek *αὐτο-* (auto-) 'self', and ποίησις (poiesis) 'creation, production'). [1609] The term autopoiesis refers to a system capable of producing and maintaining itself by creating its own parts. It describes the property of a living system, such as a bacterial cell or a multicellular organism, that allows it to maintain and renew itself by regulating its composition and conserving its boundaries. In simpler terms, the concept ‘life’ *is* self-creation or self-production as self-organizing systems which also includes interaction with the environment. Hegelian advocates of autopoiesis are careful to point out that this notion is not based on mechanism. Instead, some of them explain this as moving towards higher levels of unity or organization which cannot be thought of simply as a sum of mechano-bio parts. Very simplistically the idea is that the whole exceeds the parts in a very special and explicit technical fashion. Dr. Wendell Kisner in his book “Ecological Ethics and Living Subjectivity in Hegel's Logic: The Middle Voice of Autopoietic Life” writes,

> But when we get to higher level autopoietic unities the limits of the system may not be observable, either because the observer mistakenly makes a distinction within a metadomain that does not belong to the autopoietic unity in question or, because of the character of his own autopoietic process, “he may be unable to interact in the space in which the system is realized as a unity.” [1610]

Biological systems are not enclosed within themselves in a ‘metadomain’, a reductionary classical flawed notion, but interact with their environment, the other, to be what they *are*. Biological systems interact with their environment in a way that not only mimics concept but actually *is* concept in a highly technical sense.

Kisner states that in order for interactions with the environment to occur the organism must recognize, set up an interaction with its environment which is not simply 'the environment' but some kind of "*description*" of the environment to itself. He asserts that this would comprise some form of self-consciousness.

> If the organism can then generate such "descriptions" of its own self-relations, again made possible by the interactions with interactions at the initial metalevel, and can in turn make these descriptions themselves into objects of interaction (at a meta-metalevel, as it were), it has become self-conscious. 1611

Kisner, like Hegel, considers the idea that organisms are merely mechanical and sealed within themselves to be from a demented essentialist perspective. Essentialism assumes concepts arise from human self-conceptualizations (kant-ingly) and as such assumes that 'concepts' are hermetically themselves, as things-in-themselves. In this errant notion concepts must also be sealed off from 'reality'. This is the standard classical essentialist view. For Kisner and Hegel 'knowing something' implies co-creation or more accurately concretion – more concrete and less abstract. Conceptualization is simply a different, perhaps higher, organizational level for all biological systems. There are no bipolar things and ideas about things but higher order transformational unities. But history has conditioned us to call these higher more concrete unities - 'concepts'.

There are two ways of thinking about higher transformational unities. One way is that the higher unity arises from itself. The other way is to think that the higher unity produces something entirely different from itself. This latter idea is called *allopoiesis* (from allo- Greek prefix meaning other or different) and -poiesis (Greek suffix meaning production, creation or formation) 1612. For autopoiesis the higher unity arises from within the organism. For

allopoiesis the higher order arises as something fundamentally different from the lower order, the parts. In both cases higher order, transformational unity cannot be reducible to parts. For allopoiesis the higher order has a discrete 'jump' which produces an order fundamentally different than the lower order of its parts. For autopoiesis there is still a transformation but one that is not extraneous to the lower parts of the organism. This is where the highly specialized notion of 'concept' comes in.

Concepts should be thought of more like topologies or perhaps what I have referred to as boundary conditions. As we saw with blackholes, the event horizon is a boundary condition for the end of spacetime, the volume of the blackhole that leaves the mechanism of spacetime behind and takes its leave altogether of classical ways of thinking. But the holographic principle and AdS/CFT mathematics demonstrates that the volume of the blackhole is encoded by the topology, the boundary condition, of a lower dimensional surface in the event horizon. Likewise, concepts may analogously relate more to the volume of the blackhole for a living organism which would perhaps be more like the topology of boundary condition of the event horizon. And as AdS/CFT correspondence tells us, there is a mutual determinacy between the lesser dimensional event horizon and the non-spacetime-like volume of the blackhole. Even more so, recall that the informational volume of the blackhole is mutually limited by the lower dimensional surface area (topology) of the event horizon.

Further, Kisner criticizes the allopoiesis interpretation in the passage below.

> Nonetheless when they [allopoiesis interpretation] turn to "the evolution of the multicellular pattern of organization," they suggest something close to the idea of mutual teleology without actually stating it, writing that when such evolution occurs, "the component (living) autopoietic systems become necessarily subordinated, in the way they realize their

> autopoiesis, to the maintenance of the autopoiesis of the higher order autopoietic unity which, through their coupling, they define topologically in the physical space." Here the mutual teleology of the individual autopoietic systems becomes "subordinated" to the larger whole. Each autopoietic unit, through its autopoiesis, is a means for the realization of an autopoietic whole. But since that whole depends on the autopoietic character of those units, each unit is also in its own right an end and we have organic unity as a mutual teleology in which each component functions in turn as both end and means, thereby revealing the foundationalist notion of "subordination" to be misleading in this context. 1613

In keeping with the blackhole analogy above, the mutual reciprocity of the event horizon and the end-spacetime-volume of the blackhole would be reduced to a situation where the non-spacetime-volume of the blackhole would be asymmetrically determinate of the event horizon. By "asymmetrically determinate" I mean that the allopoiesis interpretation would tell us the lower dimensional event horizon would 'dictate' the higher dimensional, end of spacetime's, volume. Analogously, this is the classical Kantian case of concept as hermetically separate from existence, hierarchically dominating environment – the classical approach. Nevertheless, for Kant, instead of concept as the older classical notion of absolute Cartesian duality of mind and body, Kant ends up essentially making concept as the unknowable thing-in-itself. And this is precisely what mechanism *is* – mechano-bio parts losing any relevance other than functional, practical, (dare I say capitalistic) reduced and at the same time, abstract 'things' ready-made for transactionalism (and modernism).

Kisner goes on to attack the 'ready-made for transactionalism' abstraction as a failed attempt of a relativistic position in which all knowledge is abstractly and solipsistically related to the knower

and therefore absolute knowledge is impossible. Kisner writes,

> The final conclusion drawn from this is the familiar (absolute) claim that "no absolute knowledge is possible." The new twist is the appeal to ontogeny, but the problem of self-refuting solipsism is the same. In general however the error is, once again, the foundationalist assumption that autopoiesis is the ground of life – it is the privileged determiner to which everything biological is "subordinate." Hegel shows that this is not so – or at the very least that we need not make such an assumption. 1614

Certainly, relativistic knowledge is underneath an absolutist position or in the least a kind of sleight of hand assertion of a pure utilitarian position as 'agnosticism'. Kisner believes that Hegel offers a way out of this historic quagmire, but it will require a reevaluation of what we mean by 'concept'.

Kisner finds the symmetrical mutuality of autopoiesis to be compatible with the Hegelian conception of life. In the context of this discussion, I find that the distinction between autopoiesis and allopoiesis revolves around self/other as organizationally a binary duality and how the duality becomes more abstract or more concrete (in a Hegelian sense). In the duality becoming more abstract, it really means that the duality is not resolved but one of the terms becomes dominant over the other. In the attempt to eradicate the other pole of the duality the outcome does not succeed in its goal but simply substitutes all the adjectives, in a tautological fashion, of the subverted pole of the duality to the dominant pole of the duality – thereby increasing abstraction and sleight of hand. Therefore, for allopoiesis the so-called resolution comes at the expense of force (tautology) which undermines its own determinism in abstraction and obfuscation. Since this failure is not recoverable on its own terms, we must look for another way to see if we can alter our preconceptions to give an account which does

not fail in abstractions. For Kisner and Hegel this means we need to look afresh at the meaning of 'concept'. Specifically, we need to look for a 'phenomenology' of what the word 'concept' may inquire about. By 'phenomenology' I mean the ontological import, the lived fashion, of what 'concept' might mean in order to make Kant's illusory dualism disappear into the clear light of concreteness, of a more stable certainty. For autopoiesis higher unities are not obfuscated but taken up by a novel approach to the word 'concept'. However, in terms of my prior discussion about classical and quantum chaos theory, emergence, and novelty, I find the impulse towards a more novel approach to concept to be a more sublime and nuanced approach.

The question then between the poles of the duality, self and other which either fails in abstraction or gets taken up into a more novel direction of concept, revolves around whether there is a mutual reciprocity (both-and) or dominant unilaterality (either-or). This discussion also bleeds over into subjectivity versus objectivity. However, for autopoiesis each 'part' has "*in its own right an end*" (a *telos*) producing an "*organic unity as a mutual teleology*". Teleology as the study of *telos* has to do with the study of completion, fulfillment, and culmination. Kisner finds allopoiesis sets up a hierarchy where the higher order, the Kantian notion of concept, subjugates the lower order, the parts. Whereas autopoiesis a "*radical emergence*" where ontological determinacies are more "explicitly manifest" meaning more concretely expressed in a novel notion of concept. Kisner claims this "*radical emergence*" is "*neither dualistic nor metaphysical*" (Kisner, 2014, p. 249) Kisner claims that radical emergence as the novel notion of concept is explicitly more manifest.

Kisner maintains as Hegel does that the novel approach to concept does not destroy the duality, the lower order, but maintains, even nourishes, the lower order by unifying them into a more concrete higher order. Hegel calls this *aufhebung* meaning lifting up or holding together the dualities in a more concrete,

unison which does not undo itself by abstraction and obfuscation but maintains both poles in a more comprehensive unison of their terms. As a side note, I find this to have a corollary in Bohr's attempt to resolve the Copenhagen dispute as complementarity. Remember that complementarity tried to resolve the contradiction of wave-particle in a both-and fashion which gave resolve to the apparent contradiction. I will repeat what I said from an earlier topic - Complementarity was more like 'both-and' as opposed to 'either-or' with the important caveat that 'both-and' does not resolve to a higher order which unifies them. In this case, both-and amounts to a bold-faced contradiction which logic cannot ever resolve, even in principle due to Bell's theorem and much work afterward.

While both autopoiesis and allopoiesis maintain a higher order transformation which is not reducible to parts e.g., subjectivity and objectivity, both maintain complexity within the bounds of classical chaos theory. Classical chaos theory describes different orders in which each order has its own set of infinitesimals or in the case of the Hegelian discussion, 'sublimes' are nuanced or novel. Analogously, higher orders and lower orders for autopoiesis might be thought of as each maintaining its own set of infinitesimals which are nevertheless related mathematically as mutual reciprocity. Mathematics after all is conceptual. Autopoiesis is both complete within itself but also mutually complementary (complementarity). Allopoiesis would maintain that the lower order infinitesimals have a relationship with the higher order set of infinitesimals in which the higher order set has some determinate relationship with the lower order set of infinitesimals (a more brute and archaic hierarchy). However, common to both views are that each order is maintained whether completely determinate or at least adequately determined. In terms of quantum physics both positions are wrong. The difference here is the difference between classical chaos theory and quantum chaos theory and how they relate to emergence and novelty.

For quantum chaos redefinition of terms is irrelevant. Quantum emergence and novelty have no relationship to classical or historic terms or further refinements of these terms. I would even add that quantum emergence and novelty is not even a plethora of radical pluralism as Deleuze and Guattari envision it – at least to the extent that “A Thousand Plateaus” can be made into infinitesimals of ‘plateaus’. I find that the unfortunate word they employ of schizophrenia may carry the import of a radicality which has no relationship to classicism and struggles to find the kind of radical difference inferred by quantum chaos. The desire to signal radical emergence and novelty by the word ‘schizophrenia’ confers a pathology. Pathologies from the Greek words "*pathos*" meaning "disease" and "*logos*" meaning "a treatise or study" is a treatise or study of disease. Therefore, the word is intrinsically stricken by the radical ‘not’ of classism. Quantum physics has set philosophy on a radically different course and in so doing has brought together, once again, the ancient intuitive quest which began with a truly alien chaos. All the symbiotic launching pads of classicism labor under the paradigm of radical difference which desire to sustain themselves under classical emergence and novelty. Factually, Hegel’s own history labored rightly or wrongly under the horror of fascism and communism. The violence is repeated because personal responsibility is not ‘derivable’ from origin, rule and authority.

As the later major section of this book will explore, radical alterity facing us and spooky radical externality have come together to bring us to the inability of nuance and infinitesimals, to find words which can be said, thoughts which can be renewed, an abyss which can be bridged, before radical rupture. This rupture even must go so far as to lose footing, orientation, in the spooky observer effect and further still towards my (ownership, rule, authority, origin, etc. of) ‘self’ which cannot found itself in transactionalism or infinitesimal-isms but begins and ends in branching always undone by quantum chaos, emergence and novelty, which finds no trace. This is the end of an epoch which leaves me no choice, no avenue

from/into history and violence, but rather to responsibility, to the Other (Autrui), the debt I owe which cannot be repaid, banished or taken up by branchings, classical narratives, infinitesimals. This rupture is death as termination of what cannot be but insists on being. In the latter major section of this book the inevitability of death signals something important about life, 'my' life, about the tree of life, and the ethical debt to the Other (Autrui) from which I cannot flee even as radical alterity of the Other (Autrui) undoes 'me' branching as life. (I realize I run the risk of mysticism here which at worst would only be a naïve form of classicism and at best a gaping aberration of classicism…some risks might be worth taking…)

To Be Entangled or Not to Be Entangled – Is that a Question?

Classical physics has been convincingly shown to be a limited case of quantum physics. Classic physics as a limited case of quantum physics is built on certain assumptions like absolute time and space, cause and effect through locality, mechanistic objectivity underlying historic categories of spirit, soul, subjectivity, the self, divine creationism, rebirth, eternal life, etc. So, the question of why humans would somehow be exempt from the entire scope of quantum physics including entanglement, the observer effect, superposition and its collapse or branching, non-locality, etc. has been investigated and questioned from the beginning of quantum physics. As I stated earlier,

> Erwin Schrödinger famously called entanglement not "**one [property of quantum mechanics] but rather the characteristic trait of quantum mechanics, the one that enforces its entire departure from classical lines of thought**". 1615

> Entanglement, as "the characteristic trait of quantum

mechanics" has passed the most rigorous standards of empirical proofs and can no longer be doubted. The odd thing about entanglement is that it is so real in its empirical certainty that it has made our practical, historically based, assumptions about reality obsolete. Why would we be exempt from the rest of the universe of quantum physics?

It seems obvious to me that we are quantum entangled systems. Our bodies, mind, emotions, everything about us is entangling and being entangled incessantly. Is death total decoherence of our entangled system 'being' like 'sudden death' for entangled systems. What could 'sudden rebirth' mean to us if anything? Is life itself quantum coherence? If quantum systems are incessantly cohering and decohering, partially or fully entangling locally and nonlocally (e.g., black holes) with multiple other entangled systems, why would we exclude 'me' as some other kind of classical system? Doesn't this seem like some kind of stubborn metaphysics which has so often plagued humanity? It seems to me that assuming we are made up of the same 'stuff' as everything else, this would mean it would have to essentially include the spookiness of quantum physics. From the beginning of quantum physics there have been questions about the scope and ramifications of quantum physics for life, conscious and unconscious states, biology, evolution, intelligence, mind, etc. In 1944, Erwin Schrödinger authored a book entitled, "What is Life?" (some of this was already quoted).

In Chapter I, Schrödinger explains that most physical laws on a large scale are due to chaos on a small scale. He calls this principle "order-from-disorder". As an example he mentions diffusion, which can be modeled as a highly ordered process, but which is nevertheless caused by random movement of atoms or molecules. As the number of atoms is reduced, the behaviour of a system becomes increasingly random. He states that life greatly depends on order and that a naïve physicist may assume that the master code of a living organism has to consist of a large number of atoms.

In Chapter II and III, he summarizes what was known at the time about the hereditary mechanism. Most importantly, he elaborates on the role mutations play in biological evolution. He concludes that the carrier of hereditary information has to be both small in size and permanent in time, contradicting the naïve physicist's expectation. This contradiction cannot be resolved by classical physics.

In Chapter IV, Schrödinger presents molecules, which are indeed stable even if they consist of only a few atoms, as the solution. Even though molecules had long been known to exist, their stability could not be explained by classical physics due to the discrete nature of quantum mechanics. Furthermore, mutations are directly linked to quantum leaps.

He continues to explain, in chapter V, that true solids, which are also permanent, are composed of highly ordered crystals. The stability of molecules and crystals is due to the same principles, and a molecule might be called "the germ of a solid". On the other hand, an amorphous solid, without crystalline structure, should be regarded as a liquid with a very high viscosity. Schrödinger writes that the heredity material is likely to be a molecule, which unlike a crystal does not repeat itself. He calls this an "aperiodic crystal". Its aperiodic nature allows it to encode an almost infinite number of possibilities with a small number of atoms. He finally compares this picture with the known facts and finds it in accordance with them. 1616

In Chapter VI, Schrödinger states:

...living matter, while not eluding the "laws of physics" as established up to date, is likely to involve "other laws of physics" hitherto unknown, which however, once they have been revealed, will form just as integral a part of science as the former. 1617

He anticipates that this statement will be open to misconception and tries to clarify it. The main principle involved with "order-from-disorder" is the second law of

thermodynamics, according to which entropy only increases in a closed system (such as the universe). Schrödinger explains that living matter evades the decay to thermodynamical equilibrium by homeostatically maintaining negative entropy in an open system.

In Chapter VII, he maintains that "order-from-order" is not absolutely new to physics; in fact, it is even simpler and more plausible. But nature follows "order-from-disorder", with such exceptions as the predictable movement of the celestial bodies and the behaviour of mechanical devices such as clocks. Even those are influenced by thermal and frictional forces. The degree to which a system functions mechanically or randomly depends on the temperature. If sufficiently heated, a clock melts into a puddle of randomly moving molecules. Conversely, if the temperature approaches absolute zero, any system behaves more and more mechanically. Some systems, such as clocks, approach this mechanical behaviour even at room temperature.

Schrödinger concludes this chapter and the book with philosophical speculations on determinism, free will, and the mystery of human consciousness. He attempts to "see whether we cannot draw the correct non-contradictory conclusion from the following two premises: (1) My body functions as a pure mechanism according to Laws of Nature; and (2) Yet I know, by incontrovertible direct experience, that I am directing its motions, of which I foresee the effects, that may be fateful and all-important, in which case I feel and take full responsibility for them. The only possible inference from these two facts is, I think, that I – I in the widest meaning of the word, that is to say, every conscious mind that has ever said or felt 'I' – am the person, if any, who controls the 'motion of the atoms' according to the Laws of Nature". Schrödinger then states that this insight is not new and that the Upanishads considered this insight of "ATMAN

= BRAHMAN" to "represent quintessence of deepest insights into the happenings of the world." Schrödinger rejects the idea that the source of consciousness should perish with the body because he finds the idea "distasteful". He also rejects the idea that there are multiple immortal souls that can exist without the body because he believes that consciousness is nevertheless highly dependent on the body. Schrödinger writes that, to reconcile the two premises,

"*The only possible alternative is simply to keep to the immediate experience that consciousness is a singular of which the plural is unknown; that there is only one thing and that what seems to be a plurality is merely a series of different aspects of this one thing…*: 1618

Any intuitions that consciousness is plural, he says, are illusions. Schrödinger is sympathetic to the Hindu concept of Brahman, by which each individual's consciousness is only a manifestation of a unitary consciousness pervading the universe — which corresponds to the Hindu concept of God. Schrödinger concludes that "...'I' am the person, if any, who controls the 'motion of the atoms' according to the Laws of Nature." However, he also qualifies the conclusion as "necessarily subjective" in its "philosophical implications". In the final paragraph, he points out that what is meant by "I" is not the collection of experienced events but "namely the canvas upon which they are collected." If a hypnotist succeeds in blotting out all earlier reminiscences, he writes, there would be no loss of personal existence — "Nor will there ever be." 1619

Certainly, the fields in which these questions were raised have certainly had their share of quacks. And so has quantum physics from the beginning. Even in the early days Einstein et al. in the early years of quantum physics found plenty of naysayers from classic physicists, religious leaders, philosophers, ethicists, and even

liberal arts when it started gaining momentum. [1620]

As we have seen, there are degrees of entanglement. It is not just some psychic form of brain waves, intentional thoughts but our entire being and beyond are entangling in degrees of strongly and weakly, locally and non-locally with other many other entangled systems in *phusis*. Entanglement as our environment happens more and less in large systems and small systems making up the environment pre-spacetime. We think that measurement causes decoherence breaking up entangled systems but decoherence is reduction of state due to the observer effect. It does not destroy entanglement but in some very odd sense has already brought the observer into yet another entangled relationship. Our classical fall into state reduction results in the perception of decoherence but according to Everett this is a "relative state" reduction.

There has been a long history of physicists, some very famous in the history of quantum physics, which believed that the brain and/or the nervous system are affected by quantum systems including David Bohm. Roger Penrose, Stuart Hameroff, Hiroomi Umezawa, Giuseppe Vitiello, Walter Freeman, Karl Pribram, Henry Stapp, and David Pearce [1621] Roger Penrose stated,

> A lot of what the brain does you could do on a computer. I'm not saying that all the brain's action is completely different from what you do on a computer. I am claiming that the actions of consciousness are something different. I'm not saying that consciousness is beyond physics, either—although I'm saying that it's beyond the physics we know now.... My claim is that there has to be something in physics that we don't yet understand, which is very important, and which is of a noncomputational character. It's not specific to our brains; it's out there, in the physical world. But it usually plays a totally insignificant role. It would have to be in the bridge between quantum and classical levels of behavior—that is, where quantum measurement comes in. [1622]

However, to be fair, the relationship between quantum mechanics and the brain is still a matter of speculation. Some researchers have suggested that quantum mechanisms could help the brain process sensory input or that some brain cells could be sensitive to single quantum events. However, there is no conclusive evidence for these hypotheses and the role of quantum mechanics in brain activity remains unclear. It is worth noting that the idea of quantum computation in the brain has been explored by scientists from Trinity College Dublin. They adapted an idea developed to prove the existence of quantum gravity to explore the human brain and its workings. The brain functions measured were also correlated to short-term memory performance and conscious awareness, suggesting quantum processes are also part of cognitive and conscious brain functions. However, their results are yet to be confirmed by advanced multidisciplinary approaches. While there is no conclusive evidence for the role of quantum mechanics in brain activity, some researchers have suggested that quantum mechanisms could help the brain process sensory input or that some brain cells could be sensitive to single quantum events. The idea of quantum computation in the brain has also been explored by scientists from Trinity College Dublin, but their results are yet to be confirmed. While the research continues, we cannot yet prove what quantum physics has to do with the brain or consciousness, but it seems like there must be some connection with quanta and mind. It seems to me that it would be almost metaphysical to suggest that quanta have nothing to do with mind. In any case, our current knowledge puts us in a bit of a ‘quandary’. 1623

The Difficult Situation for Thought

What I have tried to show in this part of the book is that our normal, easily accessible notions of ‘what is’ fail to find explanations for quantum physics. Before we can even begin the difficult journey required by quantum mechanics, we need to

realize the extent of the historic certainties we bring to the journey. All the ways we want to start making sense of quantum mechanics need to be suspended. Instead of absolutes of spacetime, cause and effect, and the logic of binaries dualities we need to start from a radically different place. Everything we believe we know is emergent from quantum chaos. Quantum chaos has no 'reality' and neither is it fantasy, and neither is it an 'is'. For logic quantum chaos is nonsense, it makes no sense. Nevertheless, it underlies sense and nonsense in some kind of spooky fashion.

Earlier I used some software jargon of a virtual factory. I likened this to narratives formed in quantum wave function branching. This narrative is the production of 'me here now' already clothed with a world. I find this similar to what Heidegger called worlding. Heidegger uses the term 'worlding' as a verb to mean how we are always bestowing meaning and significance, how we experience 'world' as familiar. But for Heidegger worlding had something to do with Being. For Heidegger Being was not a noun as if it were an entity. Being is a verb. In a way it might seem appropriate to think of Heidegger's Being as a kind of quantum wave function which does us, does reality. But for Heidegger the *ontos* had a determinacy that the quantum wave function does not have. There is no chaos in Heidegger's Being albeit a case can be made for a kind of fundamental question of how Being *is*. There seems to be quite a difference between Heidegger's notion of Being and the indeterminate findings of quantum physics. The difference lies in the spooky chaotic branchings of the wave function as the observer effect. For Heidegger, the self falls into worlding. The self clothes itself in the fig leaves of a temporalizing synchronic world in which there is origin and consummation (*telos*). But the quantum wave function itself is pre-spacetime and in a complementarity fashion 'simultaneously diachronic'. In other words, the wave function in its unfathomable scope is pre-emergent spacetime meaning it has a sense of atemporal simultaneity – it cannot observe itself as self-awareness so as to fall into La Place's demon or God. As chaos, the

wave function is the simultaneous possibility of all outcomes. The wave function is not bound to temporality but can accommodate temporality in the observer effect. However, the temporal accommodation is vast multiplicities of diachronies from emergent quanta of spacetime to what must inevitably be the case, in some spooky fashion, 'me here now'. The experience of 'me here now' as worlding appears to 'me here now' as wrapped in the clothes of narratives, of classicism, as time and space. For Heidegger, 'Being' in its historic sense synchronizes all beings into a quest for its meaning. The quest and unfolding of the meaning of Being hides in all our vacuous verbs to-be. For Heidegger, the quest for the meaning of Being is the path of authenticity. Levinas differs greatly from Heidegger's interpretation of Being as the worlding of beings in the quest for authenticity.

Levinas understands this synchronic effort towards Being as forced, as the historic unfolding of violence in which the quest for the singular origin of Being's meaning depends on dominance and rule. I have intentionally used the term chaos which is highly appropriate for the entire environmental breadth of the quantum wave function without La Place's metaphysical demon. But also, in conjunction with this, I have also used the phrase radical exteriority to describe the entire environmental wave function. Certainly, the wave function is chaotic but it also has the strange observer effect which I suppose we could call complementarity but that feels more like a euphonism to me. The fashion in which on one hand, the wave function passes from complexities into pure quantum chaos and yet on the other hand, branches into 'me here now' already intact with my worlding narratives cannot synthesize itself into the unity of Being or shall I say, La Place's demon. That seems to replay once again the violence of origin. For Levinas, the self is not homogenized into Being but arises in its attempt to escape radical alterity. And not just some kind of neutral radical alterity but a radical alterity with a face, the face of the Other (Autrui), he, she, or whatever pronoun is appropriate. The self wants to violently

usurp its origin because it takes radical alterity as horrific, as the dissolution of being. The self covers itself in the ludicrous notion of its own supposed absoluteness whether as Being or Concept or Laplace's demon or God or God's chosen one to be reconciled, made one, with God, etc. But the violent retreat from radical alterity is borne on retreat from responsibility to immortalize one's own echo of oneself to the universal, the absolute. Here we have the whole context of 'making friends with the horror' from the movie "Apocalypse Now". The quest for immortality is a fool's errand which busies itself with its own preoccupation of itself. This is Narcissus which must make everything, everyone, all existence into an echo of itself. This fool's errand is a distraction from the sheer horror of its impossibility facing the Other (Autrui). the Other (Autrui) cannot be made commensurate, an exchangeable commodity, a means to an end, because the Other (Autrui) is incommensurate externality. The Other (Autrui) is not simply the chaos of the wave function but has a face, touches me in sensibility, in my embodiment, whether it be love, compassion, hatred, anger, indolence, indifference, etc. But here, now, the externality from which I flee undoing my reverberating obsessions has a face. I will get into this much more in the latter half of this book.

What is Intelligence?

This is obviously a very difficult subject to approach. It has been the subject of many philosophers starting as far back as pictograms on cave walls budding into hieroglyphics and subsequently blossoming into language. In this section I want to at least make a few observations in light of the previous discussions. It seems to me that intelligence is made up of an ability to retain the past. But retention is not static. Retention is dynamic. Biologically, neurologically, and functionally retention is geared for change and modification. We call this narrative. Classically and historically, we imagine 'narrative' to be based on static, absolute, and essential truth –

objectivity given place by subjectivity. However, every re-collection is a re-creation albeit not from scratch (as *tabula rosa*), but from, technically, networks of syntax upon syntax which get taken as semantic. As we have seen, recent research suggests that the brain rebuilds a memory every time it is recalled. Memories are no longer considered static, unchanging entities. Instead, they are fluid and subject to alteration during the reconsolidation process when retrieved. This means that even long-term memories can be modified, providing a window of opportunity for change. 1624

In other words, intelligence as we 'think' of it is geared for modification, for learning. Learning is a process of retention and protension which is transformed into predisposed 'patterns' of recognition.

Consciousness as patterns of repetitive dynamics gaze out upon the universe and intricately find a supposed causal, historic, temporal universe. We call this 'instinct for simile'. Simile, analogy, or metaphor is the basis of intuition, memory, etc. As such simile is transformation which seeks out symmetry, redundancy, pattern. Retention is not an acquired static determinism. Retention provides a launch point for recognition. Recognition leans forward towards a future. Husserl called this protention. However, all this starts much too late because the way we use the word 'intelligence' already assumes self-consciousness. Let's back up a bit because repetition and patterns are not unique to humans, to self-consciousness. We simplistically think of this ability as change.

Change is response to ever changing environmental demands. Nature and the environment work together in a kind of unison to encode patterns into biology and geology. Animals and plants thrive on this ability to survive and adapt. In fact, this is the very meaning of the idea 'adaptation'. Even geology has a pure retention of the past, the environment. Geology is an accurate map of the past. Geology retains. Geology is utterly dependent on the environment. But even that retains a kind of indemnification towards the future. Massive pressure of the earth's crust hardens and strengthens

minerals. Dirt hardens into rock. Rock hardens into granite. Diamonds are the hardest naturally occurring mineral composed of pure carbon atoms. Diamonds are atomically resistant to immense changes in the environment. But nothing, not even diamonds, can withstand the heat death of the universe or the collapse of massive amounts of matter into the singularity of a blackhole. And as we have seen carbon, in fact all atoms, are composed of elementary particles which pop in and out of existence and spookily fall, branch, collapse from the observer effect of the quantum wave function. The awkwardness of the last sentence must remain so.

Similar to the awkwardness of the wave function, temporality is another name for incessant change and hardening – falling, branching, collapsing is the definition of *isness*. Temporality is the classical name for the *mysterium* of the quantum wave function. Moreover, even the word *mysterium* has links in Latin to chemistry and alchemy. In this book I have explored very theoretical notions of how temporality might arise from *phusis*. Loop quantum gravity and the crystalizing block universe composed of worldlines try to find a 'physical' link to temporality in spacetime from spooky quanta. However, most physicists are content to let temporality have no 'physical' meaning at all for now. Instead, they are content to base their research on a purely abstract concept of temporality as linear clock ticks, a secondary, independent variable which allows them to explore, expose, and make way for predictability. Physics provides no adequate understanding of 'clock time'. Even the most accurate atomic clocks have to be fudged from time to time to conform to our abstract notion of temporality.

As I will discuss in the next major section, none of us have ever experienced linear, clock, temporality. Why? Because *phusis* does not 'experience' linear, clock, temporality. *Phusis* has multifarious and incessantly varying, stretching and compressing, 'temporalities' as for example universal times, geological times, biological times, human lifetime times, etc. Humans never experience a 'now' moment. We experience a stretch of time which is spread out from a

past to a future and is highly dependent on experiences – e.g., how we live our moments stretch as boredom and anxiety or compress as excitement and happiness. This is not to imply the abstract binary duality which closes off excess in the idea of pure 'subjectivity'. Certainly, we try to fit this stretch of temporality into our historic abstraction of clock time. But that does not 'prove' clock time. Rather it proves something else quite profound – our ability to *be* as historical, as self-consciousnessly carrying a plethora of narratives from ancient times to current times around with us in an ability which regenerates the past afresh with modifications each time - as a project each time which aims toward a future.

Previous discussions in this book go so far as to give us a biological basis in reconstructions on brain neurology upon 're-membrance'. The active ability each time to interact with the environment by recreating a kind of simile of the past provides context and orientation towards future determinations. However, this dynamic irretrievably decoheres into remnants of memory, previous repetition and patterns, and is typically taken as some kind of historical, metaphysical identity which would homogenize all previous regenerative determinations as 'the same'. Classicism informs us with the 'certainty' of commonsense that re-collection exists in some enduring epistemology of the same. In other words, knowing is based on some assumed static determinative. The certainty of this derives from a binary dualism which informs us that otherwise we would live in a new reality every moment, which would be nonsensical. However, the excess to such reductions is that the difference in recreation, in simile, is what makes reflection possible. In our lived 'knowing' we are not enslaved to some master thought. We are not condemned to perpetual 'think' the past as 'it really was'. The past is not eternal reoccurrence of the same as Nietzsche thought. The ghost of biological simile represents previous recollections in the radical 're-membrance' of an active recollection. Just as the branching of the quantum wave function carries a random but probable prediction of a particle's property

upon observation, the superposition of accumulated memories decohere upon re-collection. Both the memory (the observed state) of the observer and the simultaneity of the unbranched wave function do not recognize collapse or existence. Each reenactment of memory nevertheless retains novelty. Like the branching of the quantum wave function with the observer effect, 're-membrance' presents us with choice spread across the nexus of probability. What is more, the singularity of branching which is not a simple continuation of previous branches introduces radical difference. This 'pulling back from', this difference is the basis of reflection, introspection, and self-observation. Might we call this the very capacity for self-consciousness?

Aristotle refers to what we think of as self-consciousness as awareness of awareness. This ability uniquely confers upon us the possibility of a unique kind of learning. This kind of capacity to learn is not tied to the environment as passive instinct, as genetic adaptation. Learning based on self-consciousness makes possible something which might look past Harari's *Homo Deus*. Quantum intelligence does not belong to a biological family, genus, or species. For Harari *Homo Deus* itself is not conscious but possesses an intelligence which exceeds consciousness and even 'understands' consciousness better than we do. But would the limit of intelligence such as in *Homo Deus* necessarily imply branching from the quantum wave function? Could *Homo Deus* at the height of its intelligence recognize its own dependence on the radical alterity of the wave function? Could *Homo Deus* attain self-consciousness? I am not sure we can rule that out. Why? Because our evolution as self-conscious has shown us this exact dilemma which finds no classical metaphysical resolve.

The singular and spooky ability for the branching of the wave function to radically interrupt existence and knowledge and yet retain a neither subjective nor objective predictability in observation also allows the perpetual refitting of retention, the past, to the simile of historic determinations such as metaphysics of

reality, essence, religion. More generally, this capacity confers on us the capacity to take simile 'literally', to eradicate excess *visa vie* historic binary dualisms. All this will be discussed in much more detail in the next major section of this book. What is more, I find that self-consciousness is more easily accessible as a combination of complexity interrupted by chaos, by radical exteriority, which enables emergence as novelty.

One notion I hope has been clarified through the book thus far is that complexity grows beyond that imagined as classical chaos theory. Classical chaos theory still retains causality, infinitesimals which although can never find a limit in calculability, can nevertheless retain metaphysical notions of causality and origin – e.g., history taken as universally true. Quantum complexity cannot remain in classical causality. Quantum chaos must emerge exterior to itself as novelty, as 'new degrees of freedom', metaphorically perhaps as *creatio ex nihilo*, as creation from nothingness. But nothingness is impossible except in our imaginations of historic narrative (perhaps spooky singularity – chaos, underscores and reduces the idea of nothingness). Here is the root of the root and the bud of the bud – complexity in the quantum wave function 'grows simultaneously' (a contradiction in terms) as abyss – abyss which 'continues a-temporally' (a contradiction in terms) beyond complexity to chaos. Quantum chaos is not the disorder of binary dualisms but radical externality. Quantum chaos is emergence budding into novelty which has no predecessor. Self-consciousness is truly novel and emergent but not from causal complexity. The quantum wave function distinct from the observer effect 'knows' nothing about causality, temporality, existence, being, etc. because novel complexity has no origin. The observer effect should not be thought of as the historic origin of 'isness'. The observer effect is not subjective or objective, false or true. The observer effect is spooky void having no causal absolute prior but nevertheless, in a sense, gifts us with novel meaning-bestowing humanity. The gift of self-consciousness is a gift of radical alterity. More on that later. For

now, let's get back to the way self-consciousness retains and '*protains*' simultaneously me and world, self and reality.

When retention and protension are hardened into such static absolute notions as 'heritage', commonsense or superstition, they ultimately and historically set themselves up as a kind of bulwark to change, to 'environing', ultimately in the form of logic - tautology. Tautology as self-identity has filtered down into commonsense as the certainty of reality and truth. Intuition is yet another kind of commonsense crystallization of retention and protension. Intuition, like poetry, can have an unsteady apprehension which may simultaneously reflect a degree of predictability and also *at the same time* an inability for accuracy meaning a disposition towards error (so has the history of science which to its credit professes an allegiance to falsifiability). Intuition is a metaphor of history which retains significance and recommends meaning. Intuition acts as meaning-bestowing. Ancient Greece *logos* is a hazy kind of ordering and gathering of language and thought both retained and predicated. This rooted historic ability tells us something about our environment. It also provides utility and usefulness. This ability is a way of inclining our ear towards externality. It is an attentiveness to the Other (Autrui). It is a compulsion to, and call for responsibility not summation and completion.

Our historic refinement of *logos* starting from Aristotle as non-contradiction catapulted into modernity and science. Science is the rigorous attentiveness to environment even if that means historic narrative – intuition taken as absolute, has to be sacrificed. In other words, this historic attentiveness towards radical externality has shaped who we have become. But logic has been instrumental in bringing us to where we are. However, logic can never be an end result, a final resting place of the absolute as Hegel imagined. Quantum physics has shown us that logic is fundamentally insufficient. Certainly, logic has also been a tool of every force and violence including Nazism, war, the phantom of objective and absolute truth. Logic and violence is a mixed bag. As philosophers

and scientists, we find an indispensable value in the '*trueness*' of logic, in looking for consistency and predictability in our environment. But in quantum physics we have reached a place where even logic has found its limits, its *telos*, its culmination.

The spooky inability for classical determinism to envelope nature has dissipated like morning mist on a new and novel history-to-be… a future. I refer to this as the end of eras, as the end of epoch. We have gathered together our most treasured and valued certainties and bought them to the altar of quantum physics to be sacrificed. But for what? Here we must incline our ear to an other, an externality which we cannot force into logical, deterministic, absolute submission. 'Environing' as radical externality asks us to grow, to adapt yet once again. And history offers no solace or words for the abyss we currently face. However, there is one avenue which still retains promise – responsibility. Ethics is the behavior of responsibility. It is the lived embodiment of action which can find no completion in itself but must compel itself towards externality, towards what cannot come into being, into existence, into certainties as truths. In the face of nuclear and environmental extinction – even in the emergence of quantum intelligence which may well evolve beyond our primitive histories; the Other (Autrui) calls us to a face beyond our realities. It calls us towards an undeniable responsibility to grow beyond ourselves. It calls us towards ethics. I find the mythologies of growth and responsibility in the most ancient similes, intuitions, in the tree of life.

Rhizome and the Tree of Life Mythologies

I want to explore some of the oldest mythologies which have been discovered in many diverse geographical locations around the world. The quantum wave function, exformation, spooky state reduction which nevertheless grows wildly variant multiplicities of all branches simultaneously with no origin or center mythically comes to us as rhizome in the tree of life. Rhizome grows, Proto-

Indo-European idea of *bʰŕ̥ź̥ʰma, or *rhizo-phusis* which means ‘to grow *homo sapiens*’towards chaogenesis, entangled from masses of roots to branches.

> Rhizome comes from the Greek rhizoma . Rhizome is often taken as being synonymous with “root”; in botany, a rhizome is a plant structure that grows underground and has both roots (commonly, the part that grows down into the ground) and shoots (commonly, the part that grows up through the ground). The word is associated with postmodern theorists Gilles Deleuze and Felix Guattari, who use the rhizome to describe a process of existence and growth that does not come from a single central point of origin. In A Thousand Plateaus, Deleuze and Guattari name arborescence or the model of the tree as the paradigm for knowledge and practice in the modern Western world; in this model, a small idea—a seed or acorn—takes root and grows into a tree with a sturdy trunk supporting numerous branches, all linked to and traceable back to the original seed. The seed or acorn thus is the beginning point of a coherent organic system that grows vertically and progressively, continually sending out branches that are part of, and identical to, the point of origin. This arborescence, they argue, is the way Western logic and philosophy has worked: in this case, Plato might be the seed and all subsequent philosophies are outgrowths of Platonic thought.
>
> In the postmodern world, however, Deleuze and Guattari argue, the grand narrative of arborescence falls apart. They offer instead the rhizome or fungus, which is an organism of interconnected living fibers that has no central point, no origin, and no particular form or unity or structure. A rhizome does not start from anywhere or end anywhere; it grows from everywhere, and is the same at any point. As such, a rhizome has no center, which makes it difficult to

uproot or destroy; you might think of a mold or fungus, which can reproduce from any cell. Postmodern culture resembles this rhizome more than the tree, according to Deleuze and Guattari. An example of this might be the internet, the World Wide Web, which has a rhizomatic structure. It has no point of origin, no central locus, nothing that controls or shapes or organizes it: the web simply grows. You can take out any link or any website (even any web browser) without damaging or changing the internet—it continues to exist without path or pattern.

The rhizome is a-linear, multiple, spread out, all proliferating and without boundaries centers/margins or limits. This is what Deleuze terms a "horizontality" of thought. Rejecting the "Father Principle" or the principle of the otigin.-as-identity, Deleuze and Guattari argue that there is no distinction between the individual and the collective. Traditionally the individual has always been associated with desire and the collective with the law. Deleuze and Guattari instead propose a "social desire." This suggests that desire is always in movement, always constituted by different elements depending upon the situation. This, they suggest, is machine-like rather than a drama (of Oedipal representation). Desire is not lack, which suggests negativity. It is affirmative in its state of movement and change. Thus the "body without organs" (BWO) is constantly in the process of formation, deformation and reformation. The BWO is itself rhizomatic, which loses a point/channel of desire (deterritorialization) only to start off along a new path like a rhizome's, spread (reterritorialization). 1625

In the next section, I am going to deal more extensively with very ancient mythologies all over the world which predate much earlier the Genesis version of the tree of life. These very ancient mythologies of the tree of life grew up independently, from multiple

sources which have no single origin. I find these mythologies to have more to do with the quantum wave function than other ancient mythologies.

Deleuze and Guattari's book "A Thousand Plateaus" introduces the concept of rhizome as a non-linear, fluid and dynamic model of politics, philosophy and psychoanalysis that veers away from the individual, looking instead at plateaus and intensities of phenomena, rather than arboreal or hierarchical systems. The rhizome is reducible neither to the One nor the multiple. It is not the One that becomes Two or even directly three, four, five, etc. It is not a multiple derived from the One, or to which One is added (n + 1). It is composed not of units but of dimensions, or rather directions in motion. It has neither beginning nor end, but always a middle (milieu) from which it grows and which it overspills. Growth is not towards a goal of completeness in Being or Concept.

In "A Thousand Plateaus", the term "blunivocal" is used to describe a type of language that is neither univocal nor equivocal. It is a language that is open to multiple interpretations and resists being reduced to a single meaning. The term is used to describe the rhizomatic structure of language, which is characterized by multiple entry and exit points and non-hierarchical connections between concepts. In other words, blunivocal language is a language that is open to experimentation and resists being pinned down to a single interpretation. 1626

Rhizome is associated with externality because it connects any point to any other point, and its traits are not necessarily linked to traits of the same nature; it brings into play very different regimes of signs, and even non-sign states. Unlike a structure, which is defined by a set of points and positions, with binary relations between the points and blunivocal relationships between the positions, the rhizome is made only of lines: lines of segmentarity and stratification as its dimensions, and the line of flight or deterritorialization as the maximum dimension after which the multiplicity undergoes metamorphosis, changes in nature. 1627

The concept of externality is used to describe the relationship between the rhizome and the outside world. The rhizome is a metaphor for a non-hierarchical, decentralized system that is characterized by its ability to grow and spread in any direction. The rhizome is not a closed system, but rather it is open to the world around it. The concept of externality is used to describe the way in which the rhizome interacts with the outside world. According to Deleuze and Guattari, the rhizome is constantly in a state of becoming, and it is through its interactions with the outside world that it is able to grow and evolve. 1628 Life is not an end, a goal, a *telos* of completion. Life is emergence from chaos, externality we cannot understand but we imagine a freedom in which we can choose to face responsibility.

In this sense growth (*rhizo-phusis*) is entangled branching which finds temporal/spatial, classical enrootedness, chaogenesis, facing externality. Externality emerges in ancient mythologies as the tree of life. I understand this as an incredibly old intuition of externality. As we have seen the wave function is one such important case of radical externality. It certainly buds into classicism as practicality which is its greatest virtue. But its enigma is never extinguished and only grows over time. It reaches a crescendo where our historic categories no longer suffice. Exactly what it 'is' brings us to an abyss in which everything behind the simple, taken for granted word 'is' becomes the question. It *is* hard to even find ideas which address the question of ontology and epistemology from the view of quantum physics' externality. Commonsense has no place to address the wave function's mystery except in many cases by completely ignoring it for the contrived beauty of Narcissus, the self without an other. Narcissus has brought us to species level extinction. Narcissus can only desperately repeat failed histories of the past which we no longer have options for violent retreat in light of climate change and nuclear weapons. We must wrestle with this abyss to see if it can find any hope beyond the gaze of Orpheus. In physics the abyss stares at us from the quantum wave function. Facing the Other

(Autrui) is the responsibility of radical alterity, away from all of our convenient categories of understanding, making sense of, and Narcissus' echo. To face the alterity of the Other (Autrui), we have to face our own entrenchment in the histories of failed answers which have brought us to the brink of a yawning gap.

The Tree of Life

The Hebrew Genesis account of creation was written somewhere between the 6th and 5th century BC. I have already discussed Genesis' account of creation and the tree of life. But the tree of life is really a much earlier archetype found all over the ancient world. Both Buddhism (600-200 BC) and Hinduism (500-200 BC) [1629] had long traditions of the sacred tree. They were preceded by a very ancient religion called the Vedic religion (1500-500 BC). Veda means knowledge [1630] The oldest Vedic texts called the Rig Veda (book 2-9) were composed 1500-1200 BC. [1631] The sacred fig tree has a very ancient tradition.

The sacred fig (*Ficus religiosa*) is a type of fig known as a banyan. While the term "banyan" is often used specifically for the species *Ficus benghalensis*, in the broader sense of the term used here a banyan is a type of fig that starts its life as an epiphyte when its seeds germinate in the cracks and crevices on a host tree (or on structures like buildings and bridges). Figs that share a similar unique life cycle are given the generalized term "banyans" and placed together in the subgenus Urostigma. *Ficus religiosa* is a type of fig; that is, a member of the genus Ficus of the mulberry family, Moraceae. In addition to the sacred fig, other well-known figs include the common fig, *Ficus carica*, which produces a commercially important multiple fruit, and *Ficus benghalensis*, the Indian Fig Tree, which is the National tree of India. The *Ficus* genus is characterized by hundreds of tiny flowers occurring inside a fleshy, fruit-like body (a syconium). [1632]

Kalpavriksha (Sanskrit: कल्पवृक्ष, lit. 'age tree', Kalpavṛkṣa) is a

wish-fulfilling divine tree in Indian religions, like Hinduism, Jainism, and Buddhism. In Buddhism, another term, ratnavṛkṣa (jeweled tree), is also common. Its earliest descriptions are mentioned in Sanskrit literature. It is also a popular theme in Jain cosmology and Buddhism. Kalpavriksha, the tree of life, also meaning "World Tree", finds mention in the Vedic scriptures. 1633

The tree of life has countless ancient roots, similar to the physical roots of the tree itself. Archaeologists have located the symbol below in Turkey and dated it back to 7000 BC; similarly, it appears in Acadian culture around 3000 BC. 1634

1635

Many believe the Mesopotamian Tree of Life was a mythical tree that grew at the world's center. From this tree flowed the primordial waters of Apsu, the first vital water of the world.

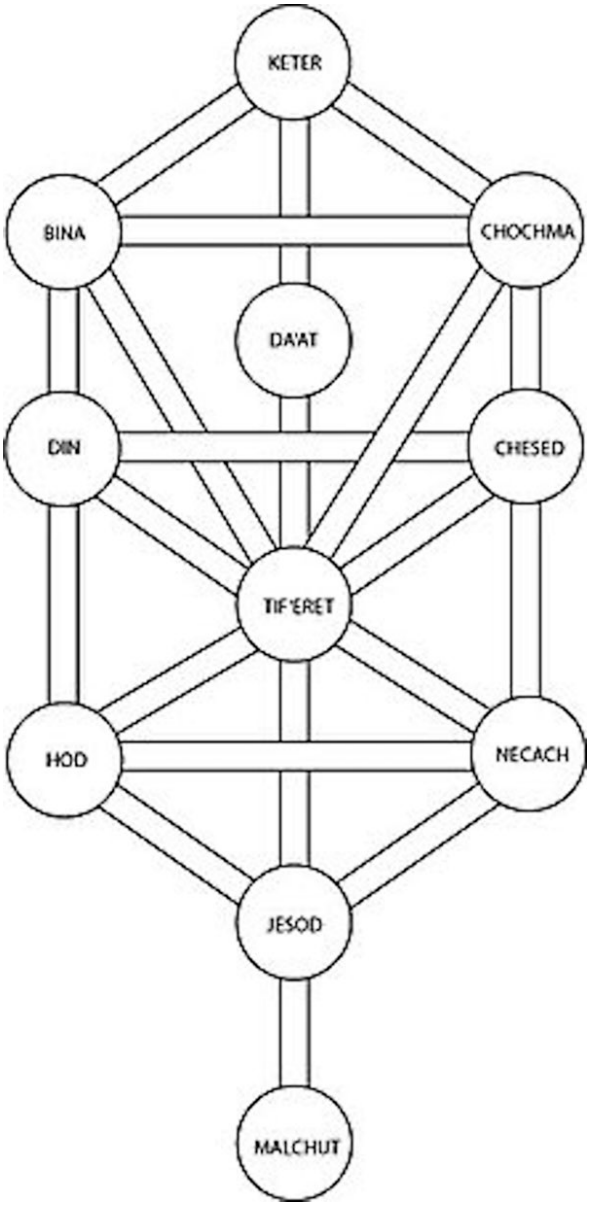
Since Apsu eventually merged with other elements to create the first Mesopotamian gods, it's clear the Tree of Life is primarily a symbol of life itself. No matter how it is drawn, the Tree represents new beginnings, fertility, connection, life cycles, and the ultimate goal of the individual.

Many scholars believe that in the Mesopotamian Epic of Gilgamesh, the "immortality" that Gilgamesh is searching for

is actually the Tree. When Gilgamesh fails to attain this immortality, the Tree comes across as a representation of death's inevitable arrival. Here, it symbolizes not only the beginnings of life but the life cycle as a whole, celebrating it as a natural progression. 1636

…

The Epic of Gilgamesh is a similar quest for immortality. In Mesopotamian mythology, Etana searches for a 'plant of birth' to provide him with a son. This has a solid provenance of antiquity, being found in cylinder seals from Akkad (2390–2249 BCE). 1637



1638

The Hebrew Kabbalistic tree of life may have its origins in Assyria in northern Mesopotamia in the 9th century BC. The

Assyrians assigned values and specific numbers to their deities, similar to those later used in Jewish Kabbalah. 1639 Jewish mysticism depicts the tree of life in the form of ten interconnected nodes, as the central symbol of the Kabbalah. It comprises the ten Sefirot powers in the divine realm. The panentheistic and anthropomorphic emphasis of this emanationist theology interpreted the Torah, Jewish observance, and the purpose of Creation as the symbolic esoteric drama of unification in the sefirot, restoring harmony to Creation.

The tree of life symbology was found in Kingdom of Urartu, divided among Armenia, eastern Turkey, and northwestern Iran, in the 9th and 8th centuries BC. It is also found in Iran in the 2nd to 1st century BC. The Kalpavriksha, also known as the “age tree” or “wish-fulfilling divine tree” has a significant place in Hinduism, Jainism, and Buddhism. The Kalpavriksha was found on a sculpture going back to the 3rd century BC. In Chinese mythology a carving of the tree of life dates back to 1200 BC.

Etz Chaim (Hebrew: עץ חיים), Hebrew for "tree of life," is a common term used in Judaism. The expression, found in the Book of Proverbs, is figuratively applied to the Torah itself. Etz Chaim is also a common name for yeshivas and synagogues as well as for works of Rabbinic literature. It is also used to describe each of the wooden poles to which the parchment of a Sefer Torah is attached. In the Book of Proverbs, the tree of life is associated with wisdom: "*[Wisdom] is a tree of life to them that lay hold upon her, and happy [is everyone] that retaineth her.*" In Proverbs 15:4, the tree of life is associated with calmness: "A soothing tongue is a tree of life; but perverseness therein is a wound to the spirit." In the Ashkenazic liturgy, the Eitz Chayim is a piyyut commonly sung as the Sefer Torah is returned to the Torah ark.

In Mesoamerica world trees are a motif in pre-Columbian cosmologies and in Maya, Aztec, Izapan, Mixtec, Olmec cultures. The Olmec civilization’s origins have been traditionally placed between 1400 and 1200 BCE, with some evidence suggesting even

earlier roots. Olmec remains discovered at the Preclassic shrine, El Manatí, near San Lorenzo moved further back to "at least" 1600–1500 BC. The Olmec seemed to have roots in early farming cultures, which began between 5100 BC and 4600 BC. [1640] The Olmecs, an ancient Mesoamerican civilization, left behind intriguing artifacts. Although not directly labeled as the “tree of life,” their complex urban centers featured large pyramidical structures and astronomical alignments. From an ancient stela found in Izapa, it is clear that the Olmec recognized the Tree of Life. The tree also depicts seven branches and twelve roots,' wrote Sabas Whittaker, M.F.A., in his book 'Africans In The Americas Our Journey Throughout The World.' This stela also confirms that the Olmec were some black people who came to Mexico in ships made of barks and landed at Pontochan. These people are frequently depicted in the Mayan books and writings carrying trade goods. 'The seven branches probably represent the seven major clans of the Olmec people. The twelve roots of the tree extending into the water from the boat probably signify the 'twelve roads through the sea.' [1641]

The tree of life is also found in the Iroquois in North America. The start of the Iroquois creation myth is shown below.

> Long before the world was created there was an island, floating in the sky, upon which the Sky People lived. They lived quietly and happily. No one ever died or was born or experienced sadness. However one day one of the Sky Women realized she was going to give birth to twins. She told her husband, who flew into a rage. In the center of the island there was a tree which gave light to the entire island since the sun hadn't been created yet. He tore up this tree, creating a huge hole in the middle of the island. Curiously, the woman peered into the hole. Far below she could see the waters that covered the earth. At that moment her husband pushed her. She fell through the hole, tumbling towards the waters below. [1642]

In Africa, the tree of life appears in Serer religion. In western Africa the Baobab tree shown below is considered the tree of life.

Baobab Tree

1643

The creation myth of the Serer people is intricately linked to the first trees created on Planet Earth by Roog. Earth's formation began with a swamp. The Earth was not formed until long after the creation of the first three worlds: the waters of the underworld; the air which included the higher world (i.e. the sun, the moon and the stars) and earth. Roog is the creator and fashioner of the Universe and everything in it. The creation is based on a mythical cosmic egg and the principles of chaos. 1644

The tree below is called the inverted tree of life (rhizome?).

1645

It comes from the Katha Upanishad as early as the 5th century BC. The Katha Upanishad hints at an eternal tree called the Ashvattha. This tree has its roots above and its branches below. It represents the interconnected universe. The silver fruit of this northern tree is the source of soma, the famous yogic nectar of immortality. Interestingly, Adam and Eve were forbidden to eat from this tree.The Ashvattha symbolizes the cosmic order, with its roots in the transcendent and its branches extending into the material world. The Mesopotamian Tree of Life, considered one of the oldest depictions of this symbol, has been found in various ancient Mesopotamian civilizations, including Assyrian, Babylonian, and Akkadian cultures. Its exact meanings are elusive due to limited written history. Some temple reliefs depict it as a palm tree, while others show intersecting etched lines. Above the Tree, a god-like figure with a ring in hand often appears. This god, possibly the Mesopotamian Sun God Shamash, signifies life and vitality. The Tree of Life likely represented a mythical tree at the world's center, from which flowed the primordial waters of Apsu—the first vital water of creation. It symbolized new beginnings, fertility, life cycles, and the natural progression of existence. The Kabbalah Tree of Life is a symbolic diagram representing God's nature, the

universe's structure, and the path to spiritual enlightenment. It consists of interconnected spheres called sefirot (divine attributes) and paths connecting them. Scholars trace its origins back to Assyria in the 9th century BC, where values and specific numbers were assigned to deities—similar to later Jewish Kabbalah. The Tree of Life appears globally in ancient art, symbolizing interconnectedness, creation, and the source of all life. Archaeologists have found this symbol in Turkey, dating it back to 7000 BC. It also appears in Acadian culture around 3000 BC. The Inverted Tree (*arbor inversa*) is rooted in the heavens and flourishes earthward. It serves as a meta-symbol for contrarianism, sacred inversion, and reverse-engineering. 1646

> In Upanishads and the Bhagavad Gita, the cosmic tree is represented as a huge inverted tree also known as inverted tree of life or upside down tree. It is a symbol that the entire universe originates from a single source. The roots of the tree are in the skies. Wisdom and creative energy is dispensed to earth through the branches…
>
> The tree of life has its unseen roots in Brahman. The tree and the branches represent Brahman in Its manifested forms. The tree grows upside down. It has its roots above (in the spiritual realm) and branches below (in the material realm).
>
> In the Katha Upanishad, an inverted tree appears as a symbol of the world itself: The universe is a tree eternally existing, its root aloft, its branches spread below. In this analogy, the physical world is rooted in Brahman. The pure root of the tree is Brahman, the immortal, in which the three worlds have their being.
>
> The Bhagavad calls the cosmic upside down tree the Ashvattha tree. The tree has roots above and the branches below (Chapter 15 verse 1). The leaves of the tree are likened to verses of poetry. Krishna identifies himself with the Ashvattha Tree (Chapter 10 verse 26) and states that He

> is the foundation of human life. “Permeating the soil, I support beings by my vital energy (Chapter 15, verse 12). Swami Bhakti Vedanta Prabhu pada talks about the upside-down tree symbolism…The root of this material existence is upward.
>
> The root of this material existence is upward. This means that it begins from the total material substance, from the topmost planet of the universe. From there the whole universe is expanded, with so many branches, representing the various planetary systems. The fruits are the results of the living entities activities. They include religion, economic development, sense gratification and liberation. 1647

In ancient Mesopotamia, the Assyrians depicted the tree of life as a series of nodes and crisscrossing lines. Its exact meaning remains a subject of scholarly debate. The oldest known example of the tree of life symbol was found in the Domuztepe excavations in Turkey, dating back to around 7000 BCE. The tree of life represents various themes, including immortality, fertility, and connection between realms. In Iroquois mythology, the tree of life is found in the heavens where the first humans lived until a pregnant woman fell and landed in an endless sea. Across different cultures, it is often associated with the world tree (such as Yggdrasil in Norse mythology) and the tree of knowledge (from the Garden of Eden in Abrahamic religions). The Assyrians in ancient Mesopotamia (around 3100 BCE) depicted goddesses of fertility alongside the sacred tree. This historical region in western Asia played a significant role in shaping the tree of life symbol. 1648

I took this photo of a banyan tree (Ficus benghalensis) 1649 on March 11, 2023, in Sri Lanka. These trees are the largest trees in the world by area and canopy coverage. If you are wondering what those long pole-like objects growing on the tree are, they are aerial roots. These roots grow down from branches into the ground to suck up water from the earth. Once they reach the ground, they

take root and become woody trunks to support the tree. Unless you have seen one it is hard to understand how enormous these trees are. The largest known banyan tree is 205,670 square feet. The length of its perimeter is 2,776 feet.

1650

In Theravada Buddhism, this tree is said to have been used as the tree for achieved enlightenment, or Bodhi by the twenty fourth buddha called "Kassapa - කස්සප". The sacred plant is known as "Nuga - නුග" or "Maha nuga - මහ නුග" in Sri Lanka. 1651 Kassapa was the third of only five Buddhas in this kalpa 1652 or age. In Buddhism a kalpa can be different lengths but a regular kalpa is 16 million years. A small kalpa is 1,000 regular kalpas or 16.8 billion years. The medium kalpa is 336 billion years. A large kalpa is 1.3 trillion years. One kalpa is called ‘a day of the *Brahma’*. *Brahma* is the Hindu god of creation. 1653 *Brahman* is the highest universal principle, ultimate reality. Earlier I mentioned that the root of *Brahman* comes from the root to grow or growth. 1654 The fourth Buddha was Siddhartha Gautama or what most people usually know as ‘the Buddha’. The Bodhi Tree ("tree of awakening"), also called the Mahabodhi Tree, Bo Tree,[2] is a large sacred fig tree (Ficus religiosa) located in Bodh Gaya, Bihar, India. Siddhartha Gautama, the spiritual teacher who became known as the Buddha, is said to have attained enlightenment or buddhahood circa 500 BCE under this tree. Wonder and imagination are found not only in Greco-

European histories but in all human histories and the tree of life is found in all of them. I have focused on Western histories as that is what I am most familiar with, but I want to make a larger point in this section.

But just like the trees of life in all these histories, even before history, there is still a trace which cannot be authenticated by archaeology as specific to any particular cultures, but the commonality of recurrent themes and archaic linguistic similarities point to much older, prior to any histories we are aware of, very old and archaic references to a tree of life. These theoretical traces which have long been erased use the prefix ‘proto’ to indicate one of these groups. A proto-language is a hypothetical ancestral language from which several attested languages are believed to have evolved, forming a language family. These proto-languages are often unattested or only partially attested, reconstructed through the comparative method. In the family tree metaphor, a proto-language can be thought of as a “mother language” or “Ursprache” (German for “primordial language”). It represents the most recent common ancestor of a language family, just before the family began diverging into the attested daughter languages. Proto-languages are not directly known; they are linguistic reconstructions. Linguists apply the comparative method to a group of languages with similar features to formulate these reconstructions. The method involves deducing a set of characteristics found in attested languages. If the entire set aligns with the proto-language, the tree (phylogeny) is considered a credible explanation. However, no tree is ever perfect due to language evolution and horizontal transfer with neighboring languages. **The concept of a single proto-language lineage is unlikely.** People spread across continents, often out of touch with each other. Over time, languages evolve, diverge, and give rise to new forms. Thus, pinpointing a singular beginning contrary to the remaining evidence. Proto-languages are like whispers from the distant past, connecting us to our linguistic heritage. 1655

A single lineage is, however, extremely unlikely. From the dawn of language, people have spread out over multiple continents, far out of touch with each other. Protolanguages must have diverged. But populations were sparse, estimates for world population at relevant times are typically below one million, sometimes well below (e.g. Huff et al. 2010), living in small tribes. From such numbers, a rough order-of-magnitude estimate of the total number of protolanguages ever spoken can be calculated (Author, submitted b). With any reasonable assumptions, the number is huge, much larger than current linguistic diversity. 1656

Here are a few universally accepted proto-languages:

- Proto-Afroasiatic: This proto-language is associated with the Afroasiatic language family, which includes languages like Arabic, Hebrew, and Amharic.
- Proto-Indo-European (PIE): Perhaps the most famous of all, PIE is the reconstructed ancestor of the Indo-European language family, which encompasses languages such as English, Spanish, Hindi, and Russian.
- Proto-Uralic: Linked to the Uralic language family, which includes Finnish, Hungarian, and Estonian.
- Proto-Dravidian: Associated with the Dravidian language family, which includes Tamil, Telugu, and Kannada. 1657

The tree of life appears in Nag Hammadi Gnosticism, Greek mythology, Manichaeism, Georgia, Germanic paganism and Norse mythology, Islam, Mandaeism. 1658 In Norse mythology, we find Yggdrasil, the World Tree, which serves as a central axis connecting different realms and supporting the entire cosmos. Yggdrasil is also associated with fate, life, and death. 1659 While the specifics may vary, the Tree of Life remains a powerful symbol across Indo-European cultures, embodying themes of continuity, immortality,

and cosmic interconnectedness.

> Proto-Indo-European mythology is the body of myths and deities associated with the Proto-Indo-Europeans, speakers of the hypothesized Proto-Indo-European language. Although the mythological motifs are not directly attested – since Proto-Indo-European speakers lived in preliterate societies – scholars of comparative mythology have reconstructed details from inherited similarities found among Indo-European languages, based on the assumption that parts of the Proto-Indo-Europeans' original belief systems survived in the daughter traditions. 1660

But I have also given examples of the tree of life above which find their way into all the proto-languages above. I have also shown evidence that the innate idea we have that all of these proto-languages and proto-mythologies converged into one *origin* is wrong. The beauty of this is in diversity, in the chaos of non-homogeneity, the mythologies all independently came up with this intuitive idea of the tree of life. Certainly, we could give a pseudo-evolutionary unity to all this as agrarian. But the tree of life mythos may rise above purely an agrarian rationalization in what we find in before-histories, before 'proto', an intuitive bent towards something more, an excess which cannot be reduced to the science of evolution – perhaps the pre-scientific urge which may not even begin with Homo sapiens. Could this intuitive bend have begun in Africa with Homo heidelbergensis, the species which gave birth to Homo sapiens, or even before that? Is *phusis* a name for something which exceeds the naming of *phusis*? I have called this an intuition in this book. But this intuition does not arise from homogeneity. It arrives from an excess to homogeneity. It arises from chaos, the lack of origin, rule, and authority.

The setting of the tree of life from time immemorable has always been in the context of cosmogonic myths. Creation myths have

always had an abyss, a yawning gap. The ancient Greeks were no originators of this intuition. In the “Tao Te Ching” Lao Tzu writes,

> There is a thing inherent and natural,
> Which existed before heaven and earth.
> Motionless and fathomless,
> It stands alone and never changes;
> It pervades everywhere and never becomes exhausted.
> It may be regarded as the Mother of the Universe.
> I do not know its name. If I am forced to give it a name, I call it Tao, and I name it as supreme. 1661

In Raymond Van Over’s book “Sun Songs Creation Myths from Around the World” 1662 he finds recurrent intuitions around the world of,

- Primeval abyss, an infinite expanse of waters or space.
- Originator deity which is awakened or an eternal entity within the abyss.
- Originator deity poised above the abyss.
- Cosmic egg or embryo.
- Originator deity creating life through sound or word.
- Life generating from the corpse or dismembered parts of an originator deity. 1663

We see in these classifications not a binary dualism at work, but origin and its excess: an abyss, a void, nothing (*ex nihilo*), a yawning gap, and chaos. The Muses of Hesiod were not the first to name such ideas, let alone to discover an intuitive need for them. Even in Genesis 1:1, we see that “In the beginning God created the heavens and the earth and the earth was without form and void.”

While Hebrew possesses a definite article ("the"), it completely lacks an indefinite article like “a” or “an.” The definite article is typically indicated by the letter *He* (ה). In the raw text, this explicit

article is absent; a strictly literal rendering of the single word *B'reishit* (בְּרֵאשִׁית) is "In beginning." If the text intended to explicitly say "In **the** beginning" as an absolute noun, the prefix would contract into ***Ba**-reishit* (בָּרֵאשִׁית). Because this definite marker is missing, some scholars argue for an indefinite rendering like "In a beginning." However, a more precise grammatical explanation is that *B'reishit* is in the construct state, meaning "In the beginning **of** [God's creating]..."

The original Hebrew text of Genesis 1:1 begins with the phrase, *"B'reishit bara Elohim et hashamayim v'et haaretz,"* commonly translated as "In the beginning, God created the heavens and the earth." Additionally, while *bara* is translated as "create," it carries the connotation of something entirely new emerging as a novelty out of the void. Indeed, the consensus of classical Jewish thinkers is that all existence is a *b'riah*—a creation out of absolute nothingness—as the simple meaning of the opening verses of Genesis implies. Before this act of creation, there was no primordial matter or energy out of which a universe could emerge, nor any natural law that could explain such an event. At the very least, this theological emergence from an absolute void mirrors the cosmic mystery of Einstein's mathematical singularity—the 'Big Bang'—where our universe bursts forth from a single, inexplicable point.

> The consensus of classic Jewish thinkers is that all existence is a b'riah out of absolute void, as the simple meaning of the opening verses of Genesis implies. Before the act of creation, there was no primordial matter or energy out of which a universe could emerge, nor any law that could explain such an event. 1664

Genesis 1:2 The earth was formless and void, and darkness was over the surface of the deep, and the Spirit of God was moving over the surface of the waters. 1665

The original Hebrew text of Genesis 1:2 reads as follows: "וְהָאָ֫רֶץ

1 "הָיְתָה תֹהוּ וָבֹהוּ וְחֹשֶׁךְ עַל־פְּנֵי תְהוֹם. The phrase "תֹהוּ וָבֹהוּ" is usually translated as "formless and empty" or "chaos and desolation". [1666] Long before scholars believed the book of Genesis was written, many of the more ancient creation myths have chaos, void, formlessness, or an abyss before the creation. The yawning gap of Hesiod was much later than these ancient myths, so the Greeks were not the first to think chaos was prior to creation.

Gensis 1:3 Then God said, "Let there be light"; and there was light.

The concept of creation out of nothing is originally thought to have come from a second century Jewish rebel group called the Maccabees. Later the Catholic church adopted the Latin doctrine of '*creatio ex nilo'*. Instead of creation out of nothing the Hebrew account has the notion of creation from 'primal chaos'.

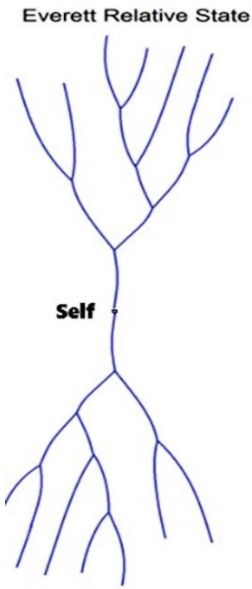
> The Hebrew Bible commences with a majestic cosmological account of the genesis of the universe. According to Genesis 1:1–2:4a (the p account according to the documentary hypothesis), God created the world in six days and rested on the seventh day. The verb brʾ used in the very first sentence of the creation story does not imply, as most traditional commentators believed, creatio ex nihilo, a concept that first appears in ii Maccabees 7:28, but denotes, as it does throughout the Bible, a divine activity that is effortlessly effected. The opening sentence in the story – many commentators think (but see Cassuto, Genesis, 1, pp. 19–20) – begins with a temporal clause, "When God began to create the heaven and the earth" (Gen. 1:1), continues with a circumstantial clause telling of the existence of the darkness and void (1:2), and then in two main clauses (1:3) relates the first act by which God, by divine fiat, created cosmic order out of **primeval chaos**: "God said, 'Let there be light,' and there was light." [1667]

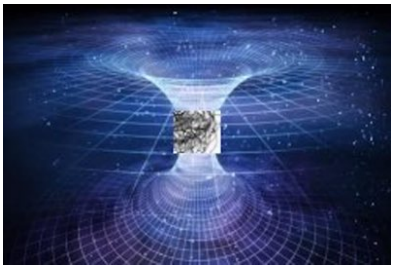
The intuitions of the tree of life and the void or chaos do not establish origin, identity, universality, and Concept. Rather they refer us to an excess which we certainly find in as spooky and undeterminable, as that which vastly exceeds our easily accessible histories, our easily accessible histories which synchronize hierarchical structures into authorized versions of 'reality'. Archaic intuitions which have left a trace in all our determinations have been erased in commonsense, in our Western assumptions of modernism. These traces are still buried in our language in the seemingly nothingness of syntax in the word 'is' and its semiotic repetition *which is history*. This constitutes 'truth'. And this is why at the end, the mediocrity of all meaning, quantum physics has unearthed something which causes seismic disruptions in 'reality' causing us to run for cover in reactionary violence that can clearly be seen in the United States as a retreat to the anti-woke, the 'way it was', the 'Last Man' of Nietzsche which must endlessly recite meaningless authoritarian voids and whose narcissism can only stare into the void blankly without seeing any other but its own face. With regard to *phusis*, can we see the other in the tree of life and the unbridgeable yawning gap?

Past the limit of spooky exformational complexities, chaos grows. Spring forth as darkened roots of singularities which cannot 'be' sprouting through as embryonic sunlit shoots spring forth as praise for Suns, for cosmologies, but simultaneously without rootedness, without origins, sprouting histories as branches which must forever remain entangled branches contradicted as excess. Ancient notions of *Phusis*, exceeds origin and observes origins. The quantum wave function finds no place in certainties of ontology or epistemology, growth exceeding the one and the 'not' the one. Emergence as radical externality, the fertile subterranean, earth-soaked abyssal root, breaking forth novel creeping darkened rootstalks towards buds of sky-spread branches, entangling nodes and internodes ever upward-growing as the surplus of chaos which observes. Entangling, inner-woven, outer-woven concurrently,

concomitantly, never returning to echoing sameness and symmetry. Yet, burgeoning life-blossoms as germinating externalities pullulating multiplicitous singularities. Rhizomic trees of life-facing radical alterities always summoning responsibility,

Narcissus perpetually echoing itself in classic-dying gazes - Orpheus' Eurydice one step away from the land of the living in the Tartarian cave,
or
Radical externality - the Other (Autrui) who faces us as the still small voice of responsibility.





1669

1670

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See Bronshtein's physics cube

10 See What is the difference between the inertial and gravitational mass?

11 See What is the difference between the inertial and gravitational mass?

12 See Mass-energy Equivalence

13 See Photon Mass

14 See What is Inertial Frame of Reference?

15 See What is Inertial Frame of Reference and What are Its Properties?

16 See Conserving Momentum: The Relativistic Mass Increase

17 See Why the Higgs and Gravity are Unrelated

18 See The Higgs FAQ 2.0

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24 See Newton's law of universal gravitation

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Interestingly, George Paget Thomson won the Nobel Prize for proving the electron is a **wave**, just 31 years after his father, J.J. Thomson, won the Nobel Prize for proving the electron is a **particle**!

See Double-slit Experiment

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See Diffraction

84 Schematic of the Double-Slit Experiment with Electrons." Image adapted from *Wikipedia, The Free Encyclopedia* and used under **Creative Commons CC BY-SA 3.0**. This diagram illustrates the 1927 verification of electron diffraction, confirming the de Broglie hypothesis.

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93 mage: "Double-Slit Interference Pattern (Green Laser)".

Attribution: Adapted from original image by Jordgette.

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See What is the double-slit experiment, and why is it so important?

94 Adapted from an original image by Jordgette, CC BY-SA 3.0 via Wikimedia Commons. This photograph captures the physical interference fringes produced by a coherent laser source.

95 Double-Slit Interference Pattern." Adapted from an original image by Jordgette, CC BY-SA 3.0 via Wikimedia Commons. This visualization shows the alternating bright and dark fringes caused by wave interference.

See What is the double-slit experiment, and why is it so important?

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See Double-slit experiment

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See Double-slit experiment

98 See Wave-particle duality

99 Illustration of wave diffraction through a single aperture. Adapted from *Wikipedia, The Free Encyclopedia*.

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100 Illustration of wave diffraction through a single aperture. Adapted from *Wikipedia, The Free Encyclopedia*.

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101 Image: "Single-Slit Wavefront Propagation Simulation".

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102 Image: "Single-Slit Diffraction Envelope Simulation".

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103 Image: "Double-Slit Interference Fringes (Red Laser)".

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See Double-slit Pattern

104 Image: "Wave interference in water due to two sources".

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Also, Double-slit experiment

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111 Image: "Comparison of Classical Water Interference and Quantum Interference Fringes".

Attribution: Panel (a) adapted from classical wave mechanics; Panel (b) adapted from an original image by Jordgette, CC BY-SA 3.0 via Wikimedia Commons.

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For a more complete 3D collection see Hydrogen orbitals 3D

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And Quantum common sense

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2 The Dirac Equation: Describes the 1928 equation by Paul Dirac as the "crowning achievement" of the field. It explains how this equation naturally predicts electron behavior and antimatter without needing "fudge factors."

3 Quantum Field Theory: Explains how particles are viewed as field quanta and discusses the processes of matter creation and annihilation, which are cornerstones of modern particle physics.

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* KaleidoTile, Topology and Geometry Software, Jeff Weeks Hyperbolic plane regular tiling: t0(4 3 3)

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are typically classified by their spatial dimension, which is indicated by a number written after the D. A D0-brane is a single point, a D1-brane is a line (sometimes called a “D-string”), a D2-brane is a plane, and a D25-brane fills the highest-dimensional space considered in bosonic string theory. D-branes are intrinsically non-perturbative and have played a significant role in the development of string theory.

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While Latin deus can be translated as and bears superficial similarity to Greek θεός theós, meaning "god", these are false cognates. A true cognate is Ancient Greek Zeus, king of the Olympian gods in Greek mythology (Attic Greek: Ζεύς, romanized: Zeús, Attic Greek: [zdĕu̯s] or [dzĕu̯s]; Doric Greek: Δεύς, romanized: Deús, Doric Greek: [dĕu̯s]). In the archaic period, the initial Zeta would have been pronounced such that Attic Ζεύς would phonetically transliterate as Zdeús or Dzeús, from Proto-Hellenic *dzéus.

By combining a form of deus with the Ancient Roman word for "father" (Latin: pater, ['pa.t̪er]), one derives the name of the mythical Roman equivalent of Zeus: the sky god Diespiter ([d̪i̯'ɛs.pɪ.t̪ɛr]), later called Iuppiter or Jūpiter, from Proto-Italic *djous patēr, descended from Proto-Indo-European root *Dyḗws*Pahtḗr literally meaning 'Sky Father'. From the same root is derived the Greek vocative "O father Zeus" (Attic Greek: Ζεῦ πάτερ, romanized: Zeû páter), and whence is also derived the name of the Hindu sky god Dyáuṣ Pitṛ́ (Vedic Sanskrit: Dyáuṣpitṛ́, द्यौष्पितृ), and Proto-

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The researchers considered a two-stroke two-qubit quantum engine in which one qubit is coupled to a hot bath and the other to a cold bath. In the first stroke, a physical quantity associated with the two-qubit system is measured in a way that alters the system's state. In the second stroke, the energy exchanged during the measurement is released from each qubit to its bath.

Upon analyzing the overall energy flow in this setup, the team finds that, for a random choice of the measured quantity, heat most likely flows from the measurement apparatus to both baths. However, calculations also reveal up to a 50% chance that heat flows from the cold to the hot bath as the measurement injects energy. This quantum-measurement cooling occurs as long as the measured quantity probes qubit states that are entangled. The team says that this approach to quantum refrigeration could be implemented with existing solid-state superconducting qubits.

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2

Phusis: Towards Radical Exteriority as Philosophy

In previous sections I have tried to show how quantum physics has introduced a radically other orientation to anything we think of as 'reality'. These findings are uncomfortable as,

- They rest on the confidences we have in science.
- We have no easy way to make sense of these ideas.

I have also tried to put these disturbing truths into a social and historical context to show how in many different avenues our social, political, cultural, and environmental securities are being eroded from within by sociological externalities which cannot be reconciled to our basic commonsense presumptions of the 'real world'. The reactionary way back to safe classicisms is mutually assured self-destruction. Extremists and authoritarian reactions want to reinstate worldviews which are being denuded of their confidences not from the outside but from within themselves. First, we need to recognize that we can no longer insist 'reality' adhere to centuries of history which established them. Second, we need to let externality, the insufficiency of everything we thought we knew as 'reality' simply speak without reacting emotionally with insecurity, fear, anger, or retreat. We need to let go of having to know to simply listen and learn. What we must let go of will mean we will not have all the security of a definite future as this is always being hollowed out from the inside. Our responsibility is not made in the choice of our freedom or adapting to a history. Our responsibilities

speak from exteriority in the saying of the Other (Autrui). Here, history and choice end. Each of us has no freedom to choose standing in the responsibility we face. Levinas understands responsibility to go far below the narratives in which we have the freedom to choose. We desire to retreat away from radical alterity and towards the depletion of self into the retreat of ego. In a way, I see Levinas asking us to become more like little children, starting yet again on the path of superposition-like birth forging towards unimaginable 'unfamiliars'. Levinas positions Ethics and responsibility beneath the classical tales we tell ourselves in common sense. He shows us how the abyss as chaos, classical thought in terms of the other of order, is excess - radical alterity as responsibility for the he or she who faces us and how this brings us towards a new future with vastly different repercussions for our daily lives.

The quandary we find ourselves in from physics and philosophy has been elaborated through this entire text so far. This was important so that we could feel ourselves towards a predicament which has no easy answer. Rather than retreat into fading realities of the past we need to look towards the future, chaos where the dark incestuous and abstract polarities of war and peace, mind, and body, subject and object, finite and infinite, static and dynamic, changeless and becoming, order and disorder, same and other, Being and nothing can no longer congeal into a semblance of a world. Chaos is the haze our future holds. Diminishing security is the violent demise we will face looking backwards to the past. We have little time to take, to survive as a species. We face extinction from without, the environment, and from within, nuclear annihilation in the Machiavellian despotism of war. Retreating into the past will only hasten catastrophe. First, we must begin to understand why answers from the past are insufficient and 'unable to be able'. This has been the quest so far in this book. Now, we can look forward to the void which faces us.

At the least we can say from chaos observation forces branching.

Branching can no longer be determined from epistemology and ontology, from the neutrality of essence and Being. We cannot create a fantastical new Nietzschean future based on the nobility of ascending morality. The history of ancient Greece from Hesiod and Heraclitus onward has brought us to where we are. Affirming heroically Nietzsche's infinite recurrence of the same will only bring on our current dilemma with no time left to replay it. Only chaos remains and faces us. In the face of the radical exteriority of chaos, there is no choice as our classical narratives tell us. Suicide is not a choice for relief or cessation. Suicide only addresses, is a resolution of, is cast from, classical narratives of escape, death, and nothingness. The threat or consolation of the extinction of death is based in the narrative of absolutes: spacetime, 'thingness', mechanism, and the metaphysic of nothingness. As we have seen, 'reality' is not necessarily what it seems from the cause-and-effect history of absolute time and space. What we must face is not knowing absolutely. Ideas as historical narratives are not the 'be all in all' we are conditioned to believe. Radical exteriority cannot be answered or measured by history, by spacetime, even by death. The absolute finality of the death of me as an existing subject in spacetime arrives with contingent certainty in the way sleep arrives. However, no such certainty arrives from the wave function. For Heidegger, death is the possibility of the impossibility of death, of 'me' in classicism's time and space which can no longer *be* that we must authentically face. For Levinas, death is the impossibility of all our possibility of 'me' in Being, in classicism's narratives of time and space, that we face every day. This impossibility is the 'me' of self-origin, of historic narratives of certainty which becomes 'me'. How did this possibility even come about? Isn't it from classically spun narratives which situate us in their 'realities'? Hasn't the discussion on quantum physics at least shaken some of our unfounded confidences? Why must we play these skeletal poker games of transactional confidences in our allusions of certainties? Do we have any such thing as choice? Quantum physics is telling us

that we must face an abyss where knowledge is no longer absolute and spooky excess leaves us 'unable to be able' as our lived classical narratives inform us. Even the quantum wave function tells us that we are not masters of our destiny. Our branching into classicism finds no absolute, no essence, no 'reality' but only abyssal contingency. This section will explore the radical externality which remains for each of us and humanity. Spookily, spacetime emerges from exformation as the Big Bang's Big Wave Function. Exformation is chaos in terms of spacetime but nevertheless spacetime is emergent from exformation in/with the observer effect. What we face in chaos is not spacetime but radical exteriority.

Echoes from the self-love of Narcissus are retreat from externality which faces us. The gaze of Orpheus can never *be*, or enter into, his love's presence. Self rises from simmering and glistening exteriority, gaze which cannot found its own completion, gaze which cannot found origin. Hades promises certainty, bringing narcissistic self, self-love, to presence. From the underworld's becoming to the heights of the totality of Concept cycling endlessly through presences and absences only to fall back into the hazy swamp of uncertainty. Orpheus' desperate, silent, yearnings for his self-love's completion through 'same and bad faith other' fall back perpetually and tragically into the underworld with only an uncertain "goodbye". Just as Orpheus looks backward his love flees from his sight leaving only a yawning gap. In the agony of death, Narcissus hears an echo of his name spoken by the other, his love's last goodbye. Only a flower remains of his body as an uncertain promise. We have been entranced by the echo of our own history, culture, and language. We will die but not in certainty, in spooky uncertainty. Entangled from radical externality, an other we never knew in all our effacements, we die in a shroud of haze we *know* as 'certainty'. However, can we see with a child's wonder as newness which takes no notice of dying in echoes of ourselves, our dying histories consuming us as narratives. Exformation as *phusis* brings us towards proximity to a radical exteriority we face once again for

the first time.

ON MY USE OF ANALOGY AND THE QUANTUM WAVE FUNCTION

For this major section, I want to reiterate why I use a highly unorthodox approach to Levinas in analogies of the quantum wave function. This book is not written for professional philosophers. I am doing the best I can to make Levinas relatable to folks that have never seriously studied philosophy. From the previous discussion, I simply find analogies of the quantum wave function as perhaps an easier way to get an idea of where Levinas is coming from. Just as there is a danger in reading the quantum wave function from the lens of classicism, there is a danger in reading Levinas as yet another metaphysician of history. That would be a mistake and a misunderstanding. However, anyone not steeped in the history of philosophy will find that much of his writing is inaccessible. Do I believe that these analogies between the quantum wave function and certain ideas of Levinas are more than an analogy? Well, I do believe that science and philosophy are coming together in ways which have not been possible, at least since Roman times. It has become apparent since the beginning of the 20th century that what underlies all our classical assumptions and truths has a very spooky underbelly. In fact, quantum physics is so spooky that it suspends basic assumptions from our entire philosophical history over a yawning gap. It is difficult for us to even find easily accessible words to begin to grasp what has come to the fore recently in our history. As Bohr told us, "*Anyone who is not shocked by quantum theory has not understood it.*" However, quantum physics is just beginning to scratch the surface of its far-reaching effects on the macro classical world we think of as 'real'. Even the problem of consciousness is still many years from having a good understanding of how quantum physics might account for it. The question of the other, ourselves, humanity, and its spooky rootedness as the

branching of the observer effect may be hundreds of years away (if Homo sapiens can survive that long). So, since none of us are going to be around that long we can only extrapolate from what we know now. We know and have the spooky feeling that radical exteriority accounts for all we think of as 'real', as 'true', and especially as common sense. It seems that the other and others and the phenomenon which calls itself 'me' is far stranger than history has led us to believe. But analogies, like intuition, are just that. I feel very awkward about making equivalences between Levinas and quantum physics. Any associations I make in this regard are pure speculation in an attempt to try to present Levinas' in a more accessible fashion to non-philosophers. If any philosophers or physicists ever read this book (which is highly unlikely), I have no doubt they will simply write it off as idiotic. And it may well be idiotic, but it is really only me doing the best I can to articulate a lifetime of inquiry and a hope which may be of use to someone else.

ON THE END OF SENSIBILITY

Modernity and British Enlightenment was based on sensibility. The thinking machine was the marriage of Descartes and modernity along with the Latin history of substance. Substance became the universal thing-like matter that composed all reality. However, reality is not merely a proper or authentic compilation of each animal's (inclusive of human) biological sense data. Biological senses are typically thought of as sight, smell, touch, taste, and hearing. The sensors are electrically connected to some kind of conduit like the central nervous system for humans. The conduit provides informational input and output to a processing unit of some type. For humans our brain and our central nervous system synthesizes and unifies electrical sensory neurons into a cohesive narrative which either initiates some behavior, chooses inaction, or simply goes unnoticed. The outcome of this processing determines whether a motor response is required and, if required, what kind of

motor response is initiated. However, all this is much more complicated than it seems. Let's look at a few of these complications.

The sense of touch is believed to be the first human sense to develop.

> Touch is thought to be the first sense that humans develop, according to the Stanford Encyclopedia of Philosophy. Touch consists of several distinct sensations communicated to the brain through specialized neurons in the skin. Pressure, temperature, light touch, vibration, pain and other sensations are all part of the touch sense and are all attributed to different receptors in the skin.
>
> Touch isn't just a sense used to interact with the world; it also seems to be very important to a human's well-being. For example, touch has been found to convey compassion from one human to another, according to a study published by the University of California, Berkeley.
>
> Touch can also influence how humans make decisions. Texture can be associated with abstract concepts, and touching something with a texture can influence the decisions a person makes, according to six studies by psychologists at Harvard University and Yale University, published in the June 24, 2010, issue of the journal Science.
>
> "Those tactile sensations are not just changing general orientation or putting people in a good mood," said Joshua Ackerman, an assistant professor of marketing at the Massachusetts Institute of Technology. "They have a specific tie to certain abstract meanings." [1]

This article shows how the other traditional senses of the world are not so abstract, modernistic, and detached but more complexly intertwined with how we live, experience, feel life. Multiple specialized receptors give us a sense of touch. Different receptors

detect pressure, temperature, light touch, vibration, pain, and other receptors all combine into the categorical notion of touch. There is no simple touch receptor. There is a heterogeneity, a plurality, of receptors we abstractly assign to the simple word touch. This complex heterogeneity applies to all the common words of sight, smell, touch, taste, and hearing all arouse kinesthetically, affectively, and sensually.

The assumption of mechanism ignores the observer's role in detecting complexity, where the system's collective behavior gives rise to structural modifications and new hierarchical arrangements, emergence and novelty which cannot remain confined in all our narratives. Similarly, in physics, emphasizing the constituent parts at the expense of the whole physical system can lead to oversimplified models and experiments that cannot be extrapolated to accurately describe complex physical systems. Emerging systems in physics are examples of complex systems where new and complicated properties emerge in response to collective properties and not to the sum of properties from individual parts. As we saw earlier, complexity in biology is increasingly looking towards quantum physics for answers. Problems of emergent properties in biology, learning in biological, error detection in organisms, quantum tunneling in viruses, and quantum cooling in biological systems, etc.

> Fascinating combinations of physics and biology can be understood already now. We have identified a large number of interconnects between quantum physics and the life sciences and the status of present experimental skills is great. But the complexity of living systems and high-dimensional Hilbert spaces is even greater.
>
> When we talk about quantum information, the discussion always circles around exponential speed-up. But in living systems any improvement by a few percent might already make the difference in the survival of the fittest. Therefore,

even if coherence or entanglement in living systems were limited to very short time intervals and very small regions in space—and all physics experiments up to now confirm this view—simple quantum phenomena might possibly result in a benefit and give life the edge to survive.

We still have to learn about the relevance and evolutionary advantage of quantum physics in photosynthesis, the sense of smell, or the magnetic orientation of bird. We still do not know whether quantum entanglement is useful on the molecular level under ambient conditions, whether quantum information processing could possibly be implemented in organic systems. We still do not fully understand and appreciate the philosophical implications of the quantum-to-classical transition even under laboratory conditions.

We thus conclude that the investigation of quantum coherence and entanglement in biological systems is timely and important. And it will need even more visions, further refined theories, and above all—a significantly broadened basis in carefully worked out and interdisciplinary experiments. [2]

Aristotle wrote of accidental properties. We might now think of these as emergent.

”A second way one might characterize the autonomy of emergent entities is through realization by base properties that does not depend on any specific realization.”

“Almost all accounts of emergence suppose that emergents are not just distinct from, but also distinctively efficacious as compared to, their bases. Weak emergentists typically deny that emergents have any fundamentally new powers, on grounds that such new powers would be, either directly or indirectly, powers to produce certain basic

physical effects, violating the causal closure of the fundamental physical realm. They maintain, however, that distinctive efficacy does not require having a new power. Distinctive efficacy might be understood in terms of distinctive counterfactual patterns over time, yoked to a counterfactual account of causation (LePore & Loewer 1987 and 1989); difference-making or "proportionality" considerations in accounting for macroscopic as against microscopic effects (Yablo 1992); or more generally through the proposal that special science laws track comparatively abstract levels of causal grain (Antony & Levine 1997, Wilson 2010)…

Strong emergentists, by contrast, standardly take emergents to introduce fundamentally novel causal powers—powers that their lower-level physical bases do not have. These are often taken to be powers of the high-level features themselves, and are directed "downwardly" at the structures from which they emerge (as well as "horizontally" in contributing to emergent features of the system at subsequent times). But some propose that high-level structural features induce novel powers in component entities; others suggest that systemic "transformations" occur in which parts either lose their identity when caught up in emergent wholes or have their behavior transformed in virtue of such embeddedness. Details concerning these proposals are provided in section 4.2 below." [3]

Where and how do these heterogeneous sources get taken up as a word, or better, a thought which we naively take as final and explanatory? For modernity our history, language, culture, and individual choices form a network for making 'sense' from 'sensibility'. Let's observe how even in stating, "making sense from sensibility" we are really understanding something by simply repeating it in the words 'sense' and 'sensibility'. We are not

logically processing all our heterogeneous sources of information like a digital, Boolean based computer program would in order to make 'sense' of our world. The most common repetition of this kind gives us redundant and repetitive certainty that we know something (e.g. reality) and is simply summarized by the verb 'to be'. I pointed out this circularity previously when discussing how we are hindered, rendered awkwardly, in even **being** 'able to be able' to think quantum uncertainty without thinking the '*is*' from the context of quantum uncertainty which actually contests the very notion of '*is*' or the generality named by 'to be'.

Physics has proven in many ingenious and sophisticated experiments that the state of the water-tops is not just mathematical uncertainty—it **is** the uncertainty of all possibilities occurring at once in 'reality'. Let's notice the awkwardness in juxtaposing what quantum physics is telling us and what the language I used in the last sentence is telling us. The use of the words 'reality' and 'is' in writing it—***is*** *the uncertainty of all possibilities occurring at once in 'reality'—****is*** *exactly what a major thesis of this book is all about*. Are we not awkwardly doubling, tripling down again by subsequently and repeatedly writing again—***is*** *exactly what a major thesis of this book is all about*? This is not an accidental coincidence. Let's notice a kind of circularity in our use of the word '**is**' which is repeated in both statements. '**Is**' **is** the present tense, third person singular of the verb 'to be'. This awkwardness built into the structure of Western language [perhaps language as such] is a circularity fundamentally built into language which we automatically and unawares simply assume. We name this circularity 'Being'. We use it all the time as if we all know what it means. We think of being in all its grammatical forms as a kind of filler word which means nothing but somehow needs to be used to make sense of our sentences. I already discussed this in the section on Martin Heidegger. For now, let's notice that there is an awkwardness in language to even explicate, in linguistic terms, what mathematical, experimental, empirically proven evidence has told us over the last

century about “the dominant trait of quantum physics”. The circularity we are seeing is not from quantum physics. It is from language which is the product of history. The notion of ‘Being’ is the fundamental bedrock upon which our Western language is built on. It is so submerged in language that we use it all the time as if it were an invisible ‘given’, a forgotten inheritance of our history.

Quantum physics has exposed many such limitations such as:

- uncertainty which cannot find any ‘reality’ which undermines it.
- exformation which has nothing to do with cause and effect.
- the wave and/or particle in which are both true.
- the wave function which updates information or branches off ‘many-worlds’ in some spooky way. [4]

Eidetic memory is often used to mean a visual memory identically, an acuity for identity. Eidetic is from the Greek word εἶδος (eîdos, meaning form or idea). [5] Identity is an important idea in philosophy. The idea of identity **is** the basis for any kind of comparison. To recognize degrees of similarity or dissimilarity, knowingly or not, we must utilize some idea of identity. This **is** the binary in logic (*logos*). We inherently (or inheritly) know ‘difference’ by what something **is**. ‘**Is**’ **is** the double play, the repetition of the same. If we think A = A we think identity. This formulation is a statement of logic. This is called a tautology in philosophy, something which **is** or must **be** necessarily true. It **is** epistemologically certain apart from anything to do with phenomena. We could also think A **is** A. This **is** thought of as repetition of phenomenon. In this case the notion of identity **is** thought phenomenally as two phenomenally different instances which are the same in every way. This **is** the ontological interpretation of identity. Let’s notice the words bolded in the previous sentence. In logic ‘**is**’ (or ‘to be’) **is** called the copula. The

copula **is** taken as what simply and innocuously connects premises and conclusions in logic.

Socrates **was** a man.

All men **are** mortal.

Therefore, Socrates **was** mortal. [6]

Note that '*was'* and '*are'* are simply forms of the verb 'to be'. What shows itself in our language in my digression, is an inescapable repetition built into thinking itself. For Sartre this repetition has "No Exit' or what I have called the 'no exit of thinking'. Husserl's philosophy wanted to step back and look at experience without attaching any particular truth or existence value to it. He called this the eidetic reduction. This involved not theorizing about what **is** the case in any way. It also meant not simply taking, for example, classical science's findings (e.g. absolute time and space) as relevant. Husserl wanted to get back to the phenomenon itself in perception and experience. This is where lived time, lived space, lived body and lifeworld all found relevance in Husserl. I understand Husserl's intent here was to avoid the '**is'** which already comes with interpretations (which philosophers have subsequently found difficult or problematic for Husserl). Husserl was Heidegger's mentor. Heidegger accepted the hermeneutical circle of language. By this, he means how our interpretations incessantly recycle upon themselves. Heidegger wanted to phenomenologically investigate the question of Being and beings which were necessarily circular. And then came Levinas. Husserl and Heidegger were Levinas' mentors. However, for Levinas, Heidegger was not deepening the question of Being but doubling down on the totality and violence of Being. He also understood Husserl as preserving the "avatars of interpretation". Here Levinas explains his issues with Hegel, Husserl, Heidegger, and much of philosophy from the ancient Greeks very compactly,

> The position of the subject in the philosophy issued from Husserl — existence, axiological emotion, practical

> intentionality, thought of Being and even man as a sign, or man as guardian of Being — preserves, across all the avatars of the interpretation, the theoretical sense of signification insofar as openness, manifestation, phenomenality, appearing remain the proper event, the *Ereignis*, the "appropriating," of *esse*. [7]

Levinas in thinking of radical exteriority wants us to ask ourselves about:

- What cannot be reappropriated?
- What cannot once again repeat the mantra of the same?
- What cannot inevitably reduce the Other (Autrui) to the same?
- What cannot reduce the Other (Autrui) to a circularity?
- What cannot reduce the Other (Autrui) to a hegemony built from 'to be', the logic of being and nothing, that must always miss and erase any trace of the he or she which faces us? [8]

The awkwardness to think quantum physics will not once again be solved, resolved, discovered in 'to be'. I plan to work through all this and more in the rest of this book. For now, let's start with philosophical history, the soil from which externality in quantum physics arises and which also makes it so difficult.

Towards an Excess

In order to understand the links between quantum physics and philosophy we need to look at our most basic common assumptions about 'reality'. We all inherit vague but practical notions about what is real. When we are born, we have no such notions. We are born in a quantum superposition-like fog which slowly 'becomes', branches into, probable certainties of our surroundings. We develop

a sense of what is real. Reality conveys practicality and repetition. These perceptions slip in unnoticed from our language, our culture, and a history which was never exclusively of the kind as ‘my personal history’.

My history is always veiled in the uncertainty of birth and the certain decay into the oblivion of death. Yet for many of us common narratives span our lifetime orienting us in a way known as 'local realism'. Local realism is the foundation of modernism. Local realism is best illustrated as the metaphysics of mechanism. A car has parts located in close proximity such as cylinders, fuel injectors, transmission, tires, etc., all made complete by an orderly arrangement which makes the car a practical method for us to get around. The local arrangement of these parts persists through time, at least until the car gets old and starts to break down. The car does not pop into existence when we need it and disappears from reality when we leave it in our garage. Locality in this case is the practical arrangement of the car’s parts which enable transportation. Realism implies the car will continue to exist when we are not looking at it. What is local realism?

> Measurements of entangled particles contradict at least one of the following two assumptions:
>
> 1. Realism: Objects have properties that exist regardless of whether anyone is observing them. Observation merely reveals properties that the objects had all along.
>
> 2. Locality: The measurement of one object can’t affect the measurement of another object that is arbitrarily far away.
>
> The combination of the two is called local realism: the assumption that objects have definite properties, independent of our knowledge of them, and independent of measurements performed on other objects. Local realism is deeply embedded in our common sense. When I measure the length of my left foot, I determine the length it already had,

> without affecting the length of my right foot. And yet this common-sense claim would be exactly wrong if my feet were entangled particles. [9]

Common sense serves us well when it comes to practical activities because our human world has already been tailored in a way which makes a certain kind of practicality a benefit. History, language, and culture tell us something very important about the kind of being we are. We are historical beings. We overlay our existence in the world with a historically acquired grid which does two things:

It informs us how to succeed or fail in day-to-day life.
It also shapes our world from generation to generation.

Narratives which tailor 'reality' and practicality have a symbiotic relationship. A symbiotic relationship is of the kind Empedocles told us about in which love and strife incessantly feed off each other as if swirling in a circular vortex. This symbiotic relationship reveals a unique capacity for being human. However, this capacity dampens our ability to deal with change. History is the record of change. It chronicles lived 'reality'. The problem with our tendency to conserve a particular narrative of history is a source of violence spawned by resistance to change. We resist change for many reasons. We are not comfortable with change. Change challenges established power structures. However, change is perhaps the only real constant over time. Evolution is all about change, emergence, adaptation. When our worldviews are undermined, there is a very natural tendency to resist the onslaught of angst which we fear will result in chaos. Chaos is perceived as a threat to cultural mores. It upsets the conservatism of day-to-day practicality. However, history is the story of the violent desire to conserve and to resist the inevitable chaos which wears the face of change. When we stop and reflect on the historic prohibition of

chaos, we certainly see that chaos in terms of disorder and order form a binary duality. Change, perturbation, introduces chaos into a system. History is the chronicle of change brought on when chaos upsets order. Conserving order is a tale we tell ourselves to repeat and prolong tragic and violent legacies. Who would even think that order itself could be the source of horrific histories? And who would think that chaos might bring value to the legacy of the survival of Homo sapiens?

Let's remember in classical mechanics, chaos arises from nonlinearity and extreme sensitivity to initial conditions. Tiny differences in initial states can lead to vastly different outcomes over time. Quantum chaos investigates how chaotic classical systems can be described using quantum theory. The central question is: What is the relationship between quantum mechanics and classical chaos? The correspondence principle suggests that classical mechanics emerges as the limit of quantum mechanics when Planck's constant approaches zero. But how does quantum chaos underlie classical chaos? Quantum systems exhibiting classical chaos often display:

- Spectral level repulsion: Energy levels avoid clustering too closely together.
- Dynamical localization: In time evolution, certain states remain localized despite chaotic classical behavior.
- Enhanced stationary wave intensities: Quantum features concentrate in regions where classical dynamics have unstable trajectories. [10]

Coherence refers to a quantum system's "quantumness." When a system loses coherence due to interactions with its environment (quantum to classical transition), quantum chaos signatures may be suppressed. This loss of coherence affects the system's ability to serve as quantum information or be manipulated. While quantum chaos primarily focuses on physical systems, its principles could

potentially impact biological processes. Adaptation in evolution involves genetic changes over generations. Quantum effects at the molecular level might influence mutation rates, genetic stability, and phenotypic variation. 11

Stuart Kauffman, a complex-systems researcher, proposed the concept of autocatalytic sets in the 1980s and 1990s. These sets consist of molecules that reproduce collectively. Kauffman suggested that if a diverse chemical soup of polymers existed, these autocatalytic sets would spontaneously emerge as a phase transition —akin to the shift from solid to liquid. These sets function holistically, mutually catalyzing the formation of all their molecular members. His inspiration came from advances in network mathematics, where phase transitions occur as connectivity increases. Kauffman's key insight is motivated by what he calls "the nonergodic world," which includes objects more complex than atoms. While simple atoms can exist in all their possible states over a reasonable time, interactions among atoms to form molecules lead to an astronomical number of possible states. Only a tiny fraction of moderately complex proteins (e.g., 200 amino acids long) have emerged throughout the Universe's history. Given these limitations, Kauffman explores how existing complexity ever comes into being. He introduces concepts like closure, where processes are linked in closed cycles, driving each other forward. Quantum laws, discovered relatively recently in the timescale of human evolution, manifest at different organizational levels: inert matter, living organisms, and cultural artifacts. These quantum laws hint at the nature of the fundamental constituents of our world and their role in evolution. Quantum nonseparability plays a crucial role in understanding emergence. T. E. Humphreys proposed the notion of "fusion," where quantum nonseparability contributes to emergent phenomena.

> In systems with broken spatial symmetry, directed transport of particles can be observed in the absence of any time-

> averaged forces or gradients, if the system is kept away from thermal equilibrium. The underlying principle of such "ratchets" has found applications in particle separation and in the modelling of molecular motors in living systems, and has also attracted much interest from a fundamental point of view. In particular, chaos in classical ratchets, and quantum effects such as tunnelling, have each been found to have a strong effect on direction and magnitude of the particle current. Here we are interested in the question how classically chaotic ratchets would behave in the quantum regime. Can chaotic behaviour be observed in quantum ratchets, or, alternatively, could ratchet effects be generated from quantum chaotic behaviour? From the point of view of experimentalists, we discuss these questions with a focus on mesoscopic electron devices, and point to possible topics for theoretical investigations. 12
>
> We present a view of the evolving reality based on our understanding of the recently discovered (in the time scale of human evolution) quantum laws, how they manifest at the different organizational levels of inert matter, living organisms and cultural artifacts, and what they possibly imply regarding the nature of the stuff the world is made of. What emerges is a pancognitivist framework in which the notion of quantumness interlaces with multiple aspects of our world, including the appearance of the complex life forms on the surface of our planet. 13

This perspective suggests that emergence cannot be reduced solely to brain states or mental substances. Emergence requires irreducible levels of explanation in physics, chemistry, and biology. This pattern of emergence offers a fresh approach to the problem of consciousness—one that transcends mere brain states or mental substances. The intersection of quantum physics and emergence is opening up new ways of understanding biology and life. 14

Athens would have never had democracy without the chaotic disruption of tyrannical order of ancient Greek clans. Athenian democracy happened because of the political changes made by Cleisthenes, who broke up the unlimited power of the nobility by organizing citizens into ten groups based on where they lived, rather than on their wealth.

15

This new democratic power structure was created to forestall strife between the traditional clans, which had led to the tyranny in the first place. The tyranny had been a terrible and bloody failure, and even the Spartans acknowledged that a moderate form of democracy would be preferable. The goal of Athenian democracy was that all citizens should have equal political rights and the ability to fully participate in either the council or the Assembly. 16 Later, chaos coming on the heels of the breakdown in feudal systems in Europe ushering in the notion of democracy. During the French Revolution in 1789, the feudal system was officially abolished. This marked a crucial turning point in European history,

as it dismantled the traditional feudal structure and paved the way for more modern forms of governance. In England, the remnants of feudalism persisted until they were abolished by Parliament in 1645. After the Restoration, Charles II further solidified the end of feudal bonds in 1660. While the system lingered on in parts of Central and Eastern Europe until the 1850s, significant reforms gradually eroded its influence. For instance, slavery in Romania was abolished in 1856, and Russia finally abolished serfdom in 1861. [17] Later, the United States fell into the chaos of its Civil War in which incompatibilities in the idea of democracy and slavery were brought to the fore. And beginning in the 20th century with relativity, quantum mechanics, phenomenology, analytic philosophy with its many linguistic turns, chaotically and controversially leading to postmodernism concurrently ushered in the idea that democracy was not sustainable when gender, ethnicity, and sexual orientation were exempted.

What does this tell us about ourselves and cultural disruptions? More importantly, let's observe that values are conserved in the historic play of reductive binary dualisms in which, for example, order is good, and chaos is bad. But the virtue of conservation can always be reappropriated in common narratives to cover over any excess to its worldview. This is how virtue always gets reassigned in the play of binary dualisms. We see this in the United States in the frenetic and violent gasp of the anti-woke conservatives who believe they are maintaining an illusory order which is deemed virtuous. The need to conserve narratives as values until the chaos of disorder perturbs the system and order can be reestablished as the new order. History has taught us this reductive scheme in which binary dualisms can never allow an excess by continual reappropriation. This is why those of us still caught up in the wake of classicism and modernism have lost the ancient sense of the externality of chaos. Even more, a sense of logic in common sense has historically given values the veneer of unquestionable absolute truth.

One important point to make here is that chaos does not necessarily include value judgements. Chaos is an agent of change, but change is not always considered good. Adaptation can go either way to increase survivability or decrease survivability. It seems to me that Nietzsche's entire passion was centered on chaos, no matter what the outcome or the pre-ordained values associated with them. For Nietzsche, the heroic Greek affirmation of tragedy (or worse eternal reoccurrence of the same) elevated the individual human and societal humans. For Levinas, what elevates humanity is Ethics based on the radical alterity of the Other (Autrui).

As was previously mentioned, in the early part of the 20th century when relativity was revolutionizing physics, phenomenology was revolutionizing philosophy. It is important to note here that an exhaustive study of the history of physics and philosophy would show us that this transition was not an abrupt change. I spent a little time discussing this transition for philosophy in my recent post on George Orwell and Emanuel Levinas (George Orwell and Emmanuel Levinas Introspective: Socialism and the Other). The point here is that chaos had already intervened in history, and always intervenes in history, to deplete the meaning bestowing practicality of existing paradigms, the *mythos* of the 19th century mechanistic worldview. The depletion of modernity, our worldview, is asymptotic, a diminishing limit. Those of us whose practicality is established and maintained under worldview, can only ever after approach a smaller and smaller significance derived in that lifeworld. This was brilliantly exhibited in 1936 with Chaplin's "Modern Times".

Modernity has exhausted itself under its norms, its values, its practicality. It no longer functions well as when an old car starts breaking down. We, as Homo sapiens, must adapt or face extinction, if for no other reason than climate change. Or, in a frenetic reaction to the impending doom of an epoch, we can forcefully impose a veneer of the old order…like a Nazi version of "Groundhog Day". Modernity is simply out of answers. Its naïve

optimism of George Jetson, space age, push button, efficiency has exhausted itself. This apparent practicality becomes more evident by dysfunctional politics and social upheavals. In its death grip, the same old tired answers bring on the rise of authoritarianism and violence around the world. The climate is dying for humans but looking great for cock roaches. When an age dies, cataclysmic events spell human tragedy or species extinction. If we cannot find a way forward, the climate we have poisoned will silence the war of all against all unless nukes beat us to it.

Since recorded history we have seen these kinds of transitions prompted by the breakdown of societal practicality. Ancient Greece was aware of this recurring movement as *peras* and *apeiron*, order and chaos. We should not be surprised that the 21st century has once again stared into this chaotic abyss which Nietzsche tells us always stares back at us. My personal studies of philosophy and science have shown me the necessity of facing the 'yawning gap'. The abyss gaped at us in the 20th century response to the breakdown of classical physics and philosophical modernity beginning with the wonder of relativity, quantum physics, and phenomenology. We have yet to fully feel its effects as we would rather sleep, and dream of days gone by. What constitutes the inflexibility of worldview and the necessity of chaos? How does practicality cease to function and lose its hold on societal norms? Is there an externality which looks us in the face and exhausts our death grip on dying realties?

When our historicity becomes absolute, it becomes a meta of *phusis*. It becomes 'reality'. It no longer merely orients our practicality. It takes on the garb of the sacred. Here sacred means it loses the capacity to be questioned. This is not as much from choice but more as a desperate fanaticism towards divination. The invisible gods of yesteryear speak in our day-to-day practicalities where our motions feel more and more like cardboard dreams. Existence takes on a plasticity, but it comes on so gradually the resignation of mere transactional gamesmanship becomes reality. Before we can allow

reflective thought to come to the fore we are already immersed in the surety of our intentions. Practicality is not mere reality, it is practice. This practice veils itself in simply 'what is', as if the matter is self-enclosed, as if it is simple tautology or what is necessarily true. This absolute reduction has more than intriguing parallels to the breakdowns of 'absolutes' in classic science such as Newton's absolute time and space. While practicality suggests a well-trod confidence in action it also imprisons action into a context which must forever remain oblivious. But chaos, change, persists. Postmodernity cast shadows of the failures of our epoch against our cave walls in conjunction with nagging questions in physics of any such absolute of 'reality' and even going all the way back to Plato's Forms. Quantum physics places uncertainty at the fore of the void left by the failure of such classical notions as 'absolute'.

> In the tradition of classical physics, the observer is a disembodied mind external to nature, and the objective essence of nature is revealed in the mathematical intuition of its structure. In quantum mechanics, however, the observer is not a disembodied mind, nor does the mathematical intuition represent an 'objective' presence but the probability of a presence. In quantum mechanics, the observer is a human consciousness embodied in instruments that serve as a bodily extension of the observer's embodiment. The empirical observations of quantum physics consequently involve a bilateral relation between the observer's enhanced embodied consciousness (on the subject side) and what is observed (on the object side), each having its place and context within the lifeworld of Nature as culture. The concepts and judgments of quantum physics consequently are contextualized subjectively and objectively by the 'natural world' as structured by science. [18]

In quantum physics and phenomenology both subjectivity and

objectivity cannot be taken ontologically as something ‘real’ or ‘existent’ from which we, the observer, can stand in a privileged position independent from ‘my observational effect’ in which objectivity thrives. Classic physics along with classic metaphysics were in firm agreement that such a perspective as purely objective was not only possible but practical. For Husserl the lifeworld was the phenomenal experience of our lived world. Our lifeworld comes to us as beliefs, emotions, and as unions of culture, language, and history. We can never merely be an absolute passive *cogito* which is removed from our immersion in experience. This notion of a god's-eye view is itself a lived immersion in phenomena not some underlying classic ‘reality’. At the end of histories and epochs, everyday practicality is the submergence of the god’s-eyed artifice in the intentional task at hand from which the context of classical history becomes determinate. However, the confluence of relativity, quantum physics, and phenomenology has interrupted historic narrative as the collapse of absolute time and space into the relativity of spacetime referential frames. But concurrently with relativity quantum physics obliterated millennia of foundations and underpinnings of classical certainties. It turns out the 'reality' itself was conjured up by history like aether. Let's step back and take a look at how perceptions on a universal and personal level converge into 'me now'.

I have already illustrated relativity and how the speed of light affects time and space under acceleration. But acceleration is gravity. There is no difference. If I am standing on a weight scale accelerating in space and I weigh myself to be the same weight that I am on earth, this means the acceleration I am undergoing is the same in space as it is on earth. We think of gravity as a force we feel on earth and that space has no gravity. This would mean that gravity is the same on the earth and in space. What is the 'same thing' is acceleration. Gravity is not really a force like the three fundamental forces of electromagnetism and the weak and strong nuclear forces. The perception of gravity as a force which always

acts locally is not correct. Gravity is really nothing other than the geometric curvature of spacetime. Our lived experience of gravity is weight. Our perception of gravity as a force is shown to be a historic narrative not what ‘gravity’ actually is.

We looked at how entangled systems give rise to notions of near and far in terms of more or less entangled. We have seen how spacetime emerges from entanglement. Remember how distance can be determined by the amount of entanglement in a system? Our body is an entangled system. Our lived experience of 'my body' is the concrete embodiment of this scientific abstraction. Our bodies are more densely entangled particles, so we ‘feel’ locality. Locality is an abstract historic narrative which we think explains this feeling. But locality does not exist as we abstractly think it does. For modernism the sense organ of the eye and light determines what we see. But interestingly, even as far back as modernism’s early voice in Descartes the sense perception of seeing was contested by what could not be doubted – thinking. But gradually seeing and all the senses became detached as Frankensteinian body parts into a universe of dead, inanimate, neutral ‘things’, matter.

In the English play Lingua, the five senses engage in combat for superiority. Ultimately, Sight is declared the victor by *Communis Sensus*, the vice regent of Queen Psyche. German Jesuit Jacob Balde also explored a similar competition in his work Urania victrix. Dutch art witnessed the emergence of allegorical paintings depicting the five senses, created by artists like Rembrandt and van Bijlert. Notably, a collaboration between Jan Brueghel the elder and Peter Paul Rubens produced a famous series of five paintings, one of which—Sight (1617)—captures diverse ideas about vision. In this painting, a young Venus sits amidst visual splendor, viewing a small painting of Jesus restoring sight to the blind. The excess of visual elements—gold coins, a peacock, and a flower arrangement—hints at the vanity of beauty and visual pleasure. Astronomical and navigational instruments scattered throughout emphasize the commercial and scientific value of optics. Animals like monkeys,

parrots, and dogs remind us of shared sensations. Extreme empiricism challenged ideas like mind, self-consciousness, self, etc. as mere idealism, asserting that sensory experiences were fundamental. Diderot provocatively stated, "*if you want me to believe in God, I would have to touch Him*," emphasizing the importance of tactile experience. Empiricism broadly emphasized the role of sensory experience in forming concepts and acquiring knowledge. [19] Seeing was irrevocably changed by 20th century relativity.

In relativity, the inertial frame is just like any other frame with the exception that we can abstractly and randomly make it our non-accelerated frame from which we view the spacetime of other frames. This means if we have two clocks running precisely together. We can place one clock in our inertial frame and put the other clock in another frame. Not only are times different for us from my lived frame observing another person's lived frame but practicality, already by narrated history, informs us that there is a simultaneity which we take as common for both me and the other. From relativity seeing is relative to frames of reference where clocks and lengths can and must change even on the smallest scales but yet appear to stay the same on larger scales. On small scales the mass of our bodies causes each one of us to have separate 'clocks' which are not synchronized. If we live on top a high rise or stand on a mountain, we age more slowly than those below on the ground where gravity is stronger. Sometimes we feel our own lived time as slow if we are bored. Sometimes we feel our own lived time as fast if we are having fun. Those kinds of feelings tend to get discounted as 'merely subjective', in which history's 'common sense' always prevails before we even think about it. Actually, lived spacetime and relativity's spacetime from which I observe the other are diachronous. They are two extremely different types of time.

Modernist notions have us believe that all our clocks are synchronized, and the senses are the gold standard of this historically abstracted narrative. Relativity's frames, on a larger scale, change the practicalities we live by. Our lives are not a

synchronized succession of events as we pass through the day. We start work at nine o'clock. We do not expect that all our synchronized clocks will run differently, causing everyone arriving at nine o'clock to start work at different times. However, this effect happens on the smallest scale even between me and you, me and the world. We are just acclimated practically to understanding reality by historic habituation, so it all appears homogeneous, the same, to us. The twentieth century's spacetime has not yet become a part of our commonsense narrative. Even more, our history colors us as all the same 'things'. Our lived spacetime and relativity's inertial spacetime frame has no absolute reference. And all our common senses get much more exasperated by exformation. Absolute is an abstraction which we take as certain. But there is no absolute spacetime and there are no absolute others who are the same as me, existing subjects in a world of objects - all taken as absolute, as what is, as common sense. 'Myself' as a randomly chosen inertial frame is relative from the smallest to largest scales of different clocks and sizes in a spooky sea of non-local, indeterminate uncertainty which has some odd connection to what I observe. History's abstract subjectivity is simply the frame we choose as a given of common sense. It is important to realize that even in our passivity we make a choice to consider all of this the 'same'. But beneath the historic narrative of freedom to choose we face the Other (Autrui) in which responsibility cannot be chosen only oriented to as retreat.

Gravitational waves propagate through the universe. Stronger ones are caused by cataclysmic events like when two blackholes combine into one. These waves wash over us changing spacetime at the speed of light. These changes cause everything in our experience to grow larger and smaller as waves and simultaneously time to go faster and slower (including all clocks) but we never feel the difference. We feel like everything just plods along as usual. The entire fabric of space time stretches and contracts as if we were in the surf on the beach. Quantum jitter is a fact of quantum particles.

It never stops. The jitter is so small it is impossible to measure on smaller particles. However, it can be measured on larger particles. We never feel it. The vacuum of space is a tight knit system of entangled particles jittering and, like bubbles that wash up on the ocean's shore, they combine to make larger bubbles of energy and disperse quickly. As mentioned earlier these virtual particles can combine to make lightning under the right circumstances and many other events we can measure. Vacuum jitter and endlessly pulsating energy below Planck levels is too small to measure directly. And this jitter is not just for the 'vacuum', this is the fabric of all spacetime. Vacuum jitter is real in its effects, but it has a hazy relationship with what we call reality. Even our biological eyes always see the past. It takes minimally about 120 milliseconds for our brain to register what the eyes see. We never 'see' the future or the present. It is always unseen. On top of that, for entanglement, an effect can come before a cause. This is Alice in Wonderland, but we call it normal, everyday, practical reality. Perhaps Alice saw more clearly than us. These are the circumstances we have found ourselves in when the 20th century shattering our naivete.

On Transactionalism

Throughout this book I have referred to transactionalism as gamesmanship. I want to clarify what I mean by transactionalism based on previous comments. Transactionalism is the economy of echo. Echo arises from narratives of history based on lived embodiment. Lived embodiment is phenomenological. In physics vernacular lived embodiment is the observer effect of branching into classical narratives as ‘myself’, as us, as narratives of reality, existence, and being. Therefore, transactionalism appeals to the self as already narrated by being-in-the-world. There is a necessity imposed by this history for acting out of self-interest as Adam Smith would tell us. But pure self-interest has played itself out in modernism’s mechanics of the self as thinking machine. The proof

of this is shown in the unabashed pride in acquiring capital. The ideal of capital acquisition has even usurped the notion of religion and democracy as the opiate of the people. While many folks regard themselves as unabashed capitalist in the United States, most folks will never reap the idealized rewards of their devotion to self-interest. Instead, all their lives they will act out their self-interest in petty gamesmanship. The game of Trump-styled, self-interest long ago was contrived as the latest and most ingenious 'public relations' stunt. This stunt was rooted in modernity's alienation of the self in the mechanism of the thinking machine of the senses. It was inevitable that marketing would become the tool of perception as reality. And technology has and is increasingly become the Matrix-styled pods where human labor and energy are harvested. In the Matrix,

> Humans are tricked into existing in a fake world that they believe to be real while their energy is being used and converted into power. Their energy is used to fuel the machines that exist in the real world, and keeping them in the pods keeps humans easy to manage and easy to harvest energy from. [20]

Just to be clear, Communism was also the just another 'public interest' campaign of the powerful few who idealized themselves as the elite creators of the type fictionalized by Ayn Rand. The answer to a successful public relations campaign is not yet another public relations campaign. The problem arises from our unique capacity as historical embodiment. Lived embodiment historically interpreted imposes a survival instinct on all of us. Death as the final ruin of the thinking machine is the mechanism for lived dreams. Dreams of immortality haunt our lived day-to-day with what Heidegger calls being-towards-death. History has evolved and afforded us an obsession with mortality which imposes a necessity to act-as-if pure self-interest, echoing ourselves back to ourselves, will bring

Eurydice back from Hades only to find that death awaits our blank stares.

From the narrative of the historic abyss on which live the hallucinations of our own echo habitually becomes practice. And, by the way, this does not necessarily involve having any explicit comprehension of the subject matter of this book. It involves a different kind of day-to-day practical choice which many folks can and do find their way towards intuitively with practical responsibility to the Other (Autrui) which does not totalize the Other (Autrui). Quantum physics has told us in no uncertain terms that all our historic narrations which found us as commonsense and day-to-day practicalities face an extreme excess. This is not the religious myth of a transcendent God. This is not the hallucination of unrestrained self-interest. This is the abyss we face where all we see is chaos. This is not the horror of disorder or its symbiotic dream of order, logic culminating in Concept. We face radical alterity not as the horror of death but as the face of the Other (Autrui) with whom we are indebted. The scope of this indebtedness will be explored in this major section of the book. We will find that the self, 'my' self, is not my invention, my origin as perpetual echo, but emerges from an embodied and lived withdrawal fleeing from exteriority which cannot come under my dominion or control. This is not death. This is the tree of life.

The Dying Epoch: Abyssal Limit Gathering Origin to Neutrality

If exformation is prior to time and space, then we can see that it might satisfy Aristotle's requirements for *telos* gathering the limit, culmination, final cause which is uncaused. Aristotle states[21], "*For the final cause is not only "the good for something," but also "the good which is the end of some action"*, the *end for some action* gathering as *telos*. If exformation is uncaused as a radical exteriority not the product of the endless chain of causes and effects in spacetime, it cannot be thought of in terms of origin. 'Origin' in this sense is

thought of as the first term in an endless series of cause and effect. It may be a helpful conceptual tool to abstractly in conformity to historic narrative to think of exformation in terms of 'the first cause' from which spacetime is emergent (perhaps, vis a vis the gravitational transformation of mass into the singularity's creation of virtual particles resulting in what we might call the Big Bang). However, the emergence of spacetime from exformation is a limited thought experiment in terms of 'kind' which we are pointing towards in thinking of exformation. Exformation is not a cause among other causes. It is not a species of a genus. It is not an element in the set of all causes. While spacetime may be emergent from exformation, exformation is oblivious to spacetime. The relationship is not one of reciprocity in which spacetime emerges from exformation and exformation is the dialectical determinate of spacetime. There is no higher order which transforms spacetime and exformation into a higher unity. Exformation is not a negative of spacetime or vice versa. Exformation is not merely the 'good for something' as in the emergence of spacetime. It is also the 'end as in culmination [*telos*] of some action' with regard to spacetime. *Telos* is the branching into classicism's narratives. As for *telos,* exformation cannot be recovered from within spacetime. It cannot be understood from the history of classic physics or even strictly from Einstein's relativity. In other words, exformation is a extreme disjuncture, a yawning gap, which is anarchic.

Exformation does not recognize form or order. It is not one 'kind' of form and order. Neither is it a negative of form and order. It cannot be thought to exist or not exist. It can only remain an uncertain haze. From the perspective of spacetime it is all information without order, without time or cause and effect. It is all possibilities instantaneously which cannot be actualized as such except as random amounts of uncertainty or chaos in the anarchic [without origin] act of observation. This is what is meant by radical exteriority. As radical exteriority exformation is the *telos*, culmination or fulfillment of not just some action but all actuality.

However, exformation does not recognize or observe this end vis a vis actuality, as objectivity. This abrupt disjunction can only be recognized as such by an attentive observer. What is meant here by 'attentive observer' is one that can recognize how extremely odd the notion of exformation is. Even the greatest thinkers of the 20th century such as Einstein, Bohr, Heisenberg, and Schrödinger who understood the ramifications of exformation were troubled by its historic incongruity. Niels Bohr, one of the most important founders of quantum physics told us that "Anyone who is not shocked by quantum theory has not understood it". [22]

In my estimation, perhaps exformation in Aristotle's sense as 'the good for something', as anything that is something, inclusive of personal and historic narratives, must be emergent from entangled virtual quantum foam popping in and out of existence which may rise from bare (virtual) existence to energy levels which can be, appropriated as 'reality' and detected and bound to wave/particles [wavicles] together with the spooky observer effect. However as discussed it makes no sense to think of exformation in reductionary terms of origin as it has a hazy exteriority in which reciprocity is irrelevant, the spooky wave function which never 'sees' (for lack of a better word) spacetime and historic narrative yet makes spacetime and historic narrative possible. Aristotle states,

> In the latter sense [**the end of some action**] it applies to immovable things, although in the former [the good **for something**] it does not; and it causes motion as being an object of love, whereas all other things cause motion because they are themselves in motion. Now if a thing is moved, it can be otherwise than it is. Therefore, if the actuality of "the heaven" is primary locomotion, then in so far as "the heaven" is moved, in this respect at least it is possible for it to be otherwise, i.e. in respect of place, even if not of substantiality. But since there is something—X—which moves while being itself unmoved, existing actually, X

> cannot be otherwise in any respect. For the primary kind of change is locomotion, and of locomotion circular locomotion; and this is the motion which X induces. Thus, X is necessarily existent; and qua necessary it is good and is in this sense a first principle. For the necessary has all these meanings: that which is by constraint because it is contrary to impulse; and that without which excellence is impossible; and that which cannot be otherwise, but is absolutely necessary. [23]

There are no "*movable things*" in the quantum wave function. Motion, force, energy, entropy, etc. are all movable things which all have to do with spacetime, things which can be moved, can have motion. Everything in motion can change implicating temporality. For temporality, entity, being, existence can be other than it is, by its very isness. If "*the heaven*", spacetime, is thought of as primary entity, being, existence its place can change (e.g., from Big Bang to now to heat death of the universe). If something can move as spacetime and all at the same time, simultaneity, cannot be moved (the quantum wave function) then there is an 'existence' to it (e.g., the observer effect) and is pure actuality while concurrently without regard to change, temporality, it moves all, branching of many-worlds, while itself is never moved (e.g., universal[24] wave function as simultaneity and all possibilities (potential). The good in Aristotle's sense is contrary to impulse, momentum, and without which excellence is impossible. Excellence cannot be other than itself and as such is "*absolutely necessary*". As excellence the good is otherwise than Being, *ousai*, awareness and beyond essence. Aristotle deems this the good. And Plato deems this the good beyond Being. This is the first principle but also an excess of first principles, *aperion* -> unlimited, without form, void, chaos as privation and its excess - therefore, "*the good*".

The quantum wave function is unmoved, does not recognize classical branching of the observer effect. Yet, it is absolutely necessary for movement, actuality, everything which 'is' and has

locomotion. It seems to me that Aristotle had one of the best explanations for the quantum wave function millennia before there was even the possibility of such an idea. I call this intuition. In Aristotle's latter sense as *"the good which is the end of some action"* exformation is the culmination of action which cannot be thought in terms of the same kind or dialectical necessity of, actuality. It only becomes actual in experimental observation. Apart from observation it cannot be thought in terms of 'actual'. This does not mean that entanglement only happens when we observe it. Nor does it mean the contrary, that it happens spontaneously without observation. It is not a binary totality which fits into historic categories. Pure subjectivity or pure objectivity is preposterous. Yet, it is responsible for everything that is anything, every transition from one quantum system's state to another. However, the essential impossibility of determination of the wave function apart from experimental observation casts an impenetrable mist upon the banks of 'reality'...like it or not. Exformation as "**the** characteristic trait of quantum mechanics" remains purely **contingent** potentiality, as the sum of all possibilities which may become actual. Even this actuality is still infected with fundamental indeterminateness. In terms of Aristotle, motion cannot be exformation. Exformation in this sense is Aristotle's unmoved mover. Exformation has no dependence on spacetime. Exformation cannot actually exist. The first principle is necessary for locomotion, for classicism's narratives. In Aristotle's notions the unmoved mover is a primary being, *ousai*, awareness and beyond essence. Locomotion is an accidental being. The good is necessary as *telos*, fulfillment, completion, excellence. We need to rid ourselves of this modernist holdover in thinking of the wave function as pertaining only to 'matter', dead inanimate stuff, because it results in our lived life and experiences as branching narratives which is neither personal nor collective but both and exceeds both making actual narratives of who we *are*.

As we have seen, exformation is before space and time, cause,

and effect, and is pre-originary. Origin achieves its necessity, its demand and requirement, through the unfolding of space and time. Origin is an after-effect, a narrative of exformation theory. The questions the predecessors of ancient Greece could never resolve was, what is the origin of 'origin'? This is because it must be an endless recursive question, "What came before X" or the well-known chicken-egg scenario. In effect, current physics tells us origin loses all meaning with exformation. Exformation does not have any relationship to origin as is commonly conceived in a classical framework. Therefore, it is anarchic by definition, literally meaning no origin in Greek. It does not recognize the relativity of time and space. It has no 'origin' in any of the historic and philosophical ways we have of understanding origin. Aristotle wrote, "matter exists potentially, because it may attain to the form; but when it exists actually, it is then in the form." (Metaphysics 1050a15. Greek: ἔτι ἡ ὕλη ἔστι δυνάμει ὅτι ἔλθοι ἂν εἰς τὸ εἶδος: ὅταν δέ γε ἐνεργείᾳ ᾖ, τότε ἐν τῷ εἴδει ἐστίν). For Aristotle, potentiality or possibility does not exist in any sense of the word. Actuality is existence with regard to motion, change, activity or for our case the relativity of time and space, cause and effect, form and order.

What Hath Quanta Wrought?

Ideally, information theory would be the record down to the most infinitesimal detail of everything that has ever happened. Information in this sense is classical information. Classical information is what we call history. That is, information is a factual recount of everything which happened to explain how transitions from one state to another occurred. The universe is a giant, inconceivable repository of all information which disappears from complexity into the limit of chaos. Even blackholes are believed to retain all information, a record of all the history of what went in them, at the 'inner horizon' just below the event horizon of the blackhole.[25] But all this information is chaotic exformation given by

the mathematical allegory of a singularity. Ideally and classically, we could recount the entire record of cause and effect since the Big Bang. This would not just be the account of physics, biology, and the natural sciences but also the histories of sociologies, psychologies, anthropologies, ethnologies of languages and customs, etc. In philosophy this school was called positivism as it believed everything could be logically or mathematically including morality and ethical judgements. In 1898 Lester Ward wrote,

> "The most important thing to determine was the natural order in which the sciences stand—not how they can be made to stand, but how they must stand, irrespective of the wishes of any one. ... This Comte accomplished by taking as the criterion of the position of each the degree of what he called "positivity," which is simply the degree to which the phenomena can be exactly determined. This, as may be readily seen, is also a measure of their relative complexity, since the exactness of a science is in inverse proportion to its complexity. The degree of exactness or positivity is, moreover, that to which it can be subjected to mathematical demonstration, and therefore mathematics, which is not itself a concrete science, is the general gauge by which the position of every science is to be determined. Generalizing thus, Comte found that there were five great groups of phenomena of equal classificatory value but of successively decreasing positivity. To these he gave the names astronomy, physics, chemistry, biology, and sociology." [26]

In his early years, Ludwig Wittgenstein was highly influenced by positivism when he wrote the *Tractatus Logico-Philosophicus* (Latin for '*Logical-Philosophical Treatise*') between 1914 and 1918. Wittgenstein wrote,

> We can say straight away: Instead of: this proposition has

such and such a sense: this proposition represents such and such a situation. It portrays it logically. Only in this way can the proposition be true or false: It can only agree or disagree with reality by being a picture of a situation" [27]

And later wrote,

The great problem round which everything I write turns is: Is there an order in the world a priori, and if so what does it consist in?" [28]

While physics in the 20th century was making all these startling discoveries philosophy was reflecting its own abstraction—shattering findings which we, as common-sense folk, have yet to even have a hint of. All of this changed with Husserl and his student Heidegger.

While quantum mechanics was taking shape in Göttingen, Leipzig, and Munich, where Heisenberg studied and worked, the phenomenology of Edmund Husserl was academically prominent. Later, Heisenberg was also one of a circle of professional scientific intellectuals who met regularly during the summer with Martin Heidegger in the Black Forest. In Germany, phenomenology and hermeneutics were *wissenschaftlich* approaches to psychology, art, literature, music, and natural science, establishing them both as 'scientific' and 'philosophical,' on a par academically with the role of logic and analysis in the contemporary USA. In addition to Husserl and Heidegger, Dilthey's work on history, Maurice Merleau-Ponty's work on perception, and Hans-Georg Gadamer's work on literature and art also inspired a strong current in European academic culture before and after the war. These currents of thought also inspired Michael Polanyi, who was Wigner's scientific mentor. [29]

The early 20th century was the last gasp of modernity's sensing machine which passively observed absolute time and space as God's eye of pure unfolding 'reality'. In modernity God's eye is my eye. My eye is locked in a prison of our lostness to historic narrative. What still remains to be seen is that seeing the other simply as my narrative of the other is precisely where my narrative fails. Another way to think of this is the practical, cultural breakdown in observation which has lost itself in its own myopia, its own covered over assumptions of a certain pre-narrated cultural motif. The resistance to what is coming and has already started around the world is a violent desperation to return to a dying 'reality'. The feeling of necessity drives this fanaticism. It is because we are not aware of the historic pathways of common sense which no longer 'work'. We intuit this socially but in passivity have not taken the time and effort to think through what is dying in our social mores. These breakdowns in 'seeing' which cannot yet see is a lens which we can also see in Einstein's own dogged determination to reject the 'spooky' action of quantum entanglement in order to find a local explanation.

> In a phenomenological analysis, it means first, that the laboratory with its measuring instruments belongs to 'the extended body' of the observer, and thus, that the observer is 'the embodied human consciousness so extended.' Consequently, the observer lives in and through the laboratory measuring instruments as oriented towards practice; this is the channel of his/her 'noetic' intentionality. Under such circumstances, the measure-number becomes just a coded messenger, and like the photons received by the eyes in seeing, the message delivered by the measure numbers is interpreted within the context of the measurement. In vision, it is not the photons which are 'observed' by the culturally prepared viewer, but the illuminated objects; so also in measurement, the measure-numbers are not what are '

> observed ' by the culturally prepared 'observer' but what they point to beyond themselves, namely, the presence of micro-systems in the laboratory situation, unaccompanied, however, by any intuitive description of them in the space-time of the laboratory. 30

The phenomenal experience of the breakdown of praxis, the inability to be able, holds the promise and threat of totem and taboo. Lived experience in action concretizes reward and punishment. It sets an expectation of a condition which minimizes the angst of lack of origin and uncertainty of death, the oblivion of birth and death. It anesthetizes the lived experience of birth and death which brings chaos to the fore. In thinking of chaos, we are bringing the lived experience of exteriority to the fore. In Western history enlightenment and modernity culminated in reducing humans to mechanism, to sensing, enlightened thinking machines failed to achieve its goal of educated, critical thinking machines. The twentieth century saw this failure in the face of two world wars, human suffering, oppression, and vast inequities in wealth distribution. It also brings to the immanent fore the threat of nuclear holocaust and the environmental extinction of the human species. Certainly, Enlightenment ushered in a fuller realization of democratic states. However, we have seen recently that social acceptance of the consequences of democracy has generated anti-democratic movements all over the world wanting to supplant democracy with authoritarian governments. This is clearly evidenced in the human extermination given by the continuing inability to overcome such authoritarian brutalities as fascism and communism. It is also shown in cultural prescriptions as ethnic bias, gender bias, and sexual preference biases. All of these failures demonstrate how power interests have found ways to exacerbate the most anti-democratic and anti-Enlightenment tendencies with the highly effective, scientific marketed motto that 'perception is reality'. In this case 'perception' is not the observer but the

determinations of the observer of the observed.

When democracy devolves into a bourgeois strategy of protectionism it is no longer democratic but a pretense for the conservation of power structures. Democracy as the government of educated and enlightened citizens stops short of the promise of capitalism when it transitions to a tool of wealth interests. Technology combined with marketing has intensified the potency of vested and invested perceptions over reality. Quantum physics' notions of uncertainty and observation and relativity's elevation of the inertial (observational) frame of reference co-arise with these economic politico-societal changes. This is not a coincidence. It is another sign of the breakdown of a worldview which can no longer function in its disappearance as practicality. The 20th century spread of democracies all over the world tells us that the seeds of Enlightenment and subsequent modernity may no longer be merely Western. Democracy has had worldwide effects both in its rise and in its demise. Many advocates of capitalism, democracy, and modernity adhere to an incremental approach of eventually fulfilling mechanistic promises. There is one immediate reason why this notion can only fail - climate change.

NASA tells us,

> Earth's climate has changed throughout history. Just in the last 800,000 years, there have been eight cycles of ice ages and warmer periods, with the end of the last ice age about 11,700 years ago marking the beginning of the modern climate era — and of human civilization. Most of these climate changes are attributed to very small variations in Earth's orbit that change the amount of solar energy our planet receives.
>
> The current warming trend is different because it is clearly the result of human activities since the mid-1800s, and is proceeding at a rate not seen over many recent millennia.[1] It is undeniable that human activities have

produced the atmospheric gasses that have trapped more of the Sun's energy in the Earth system. This extra energy has warmed the atmosphere, ocean, and land, and widespread and rapid changes in the atmosphere, ocean, cryosphere, and biosphere have occurred.

Earth-orbiting satellites and new technologies have helped scientists see the big picture, collecting many different types of information about our planet and its climate all over the world. These data, collected over many years, reveal the signs and patterns of a changing climate.

Scientists demonstrated the heat-trapping nature of carbon dioxide and other gasses in the mid-19th century.[2] Many of the science instruments NASA uses to study our climate focus on how these gasses affect the movement of infrared radiation through the atmosphere. From the measured impacts of increases in these gases, there is no question that increased greenhouse gas levels warm Earth in response.

Ice cores drawn from Greenland, Antarctica, and tropical mountain glaciers show that Earth's climate responds to changes in greenhouse gas levels. Ancient evidence can also be found in tree rings, ocean sediments, coral reefs, and layers of sedimentary rocks. This ancient, or paleoclimate, evidence reveals that current warming is occurring roughly 10 times faster than the average rate of warming after an ice age. Carbon dioxide from human activities is increasing about 250 times faster than it did from natural sources after the last Ice Age. 31

We no longer have the time for the human species to possibly and incrementally or better phantasmically reap the diminishing rewards of the promise of Enlightenment strained through the decline of modernism. It is imperative that we rise to new challenges of modernism's breakdown and the reactionary

movement back to a failing worldview. Modernism failed to root out the old face of force and violence in order to perpetually reinstall the old guard. The result of modernism's basis in the senses and self-interest is technology. Heidegger tells us that technology sets up the environment as 'standing reserve' waiting to be used. Self-interest is focused on short term gain. Pure self-interest has proven itself to be ineffective in dealing with the urgent and pending planetary apocalypse of climate change. What can we gleam from the remains of our day? How can we rise to new possibilities given the fractures of classic and enlightened 'reality'? What does this breakdown show us phenomenologically about ourselves, our societal norms of being with each other which must inevitably face the void as threat? The breakdown of order and the advent of chaos, loss of origin, implores us to lean forward into the abyss which stares back at us.

As we have seen, the classical world was a historic narrative which never really existed in phenomenon in spite of all the attempts to make it so. The *a priori* world of origin and order was an abstraction of history. As we know from quantum mechanics, the best we can do with information about physics is statistical probability. Even in classical physics probability is mathematically related to the statistical amount of uncertainty. Uncertainty is calculated by Shannon entropy calculated in bits. Uncertainty and entropy are related. Shannon entropy can range from absolute certainty about classical information to random uncertainty or maximal entropy. Quantum systems measure information very differently. Quantum information is stored as a 'qubit'. The qubit is the amount of information that can be stored in the simplest quantum system like the spin property of an electron. The point here is that absolute determinism and certainty does not exist except as a historic narrative and abstraction of science and philosophy. The end of these notions in quantum physics and postmodernism started in the late 19th century and in philosophy came to fruition in the 20th century with phenomenology.

Historically, philosophy and science have roughly followed with similar paradigm shifts. A case and point of this being the 20th century's shift in classic physics to relativity and quantum mechanics along with the 20th century's shift in philosophy with analytic philosophy's transition from positivism to the 'linguistic turn' where hermeneutics play a central role. For the continental tradition, philosophy shifted from Kantian categories of understanding and German idealism and the reaction to these movements in existentialism to phenomenology. Einstein's relativity and Husserl's phenomenology were in lock step in the 20th century. As I have mentioned, classic physics looked at time and space as absolutely linear, local, and absolutely distinct from each other. Relativity looked at relativistic frames and how spacetime is curved where time and space does not conform to our classical idea of them but distorts classical linearities in space and time as length contraction and time dilation which is not merely visceral – it is non-classical 'reality', an oxymoron of sorts. Quantum physics upends classical notions of locality. Modernity since Descartes looked for absolutes in human existence, nature, and history. Phenomenology looks at how phenomenon shows itself in cultural and personal lived frames of reference.

Classical time is abstract as absolute linear now moments proceeding from a past to a future. Phenomenology starts with how phenomenon shows itself to us apart from these philosophical and metaphysical abstractions. Phenomenology looks at how phenomenon shows itself in cultural and personal lived frames of reference. Lived temporalities have a kind of stretch from a past to a future, retention and protention, perhaps reminiscent of relative frames of reference which prohibit any kind of universal temporal synchronicity. More modern digital cultures can experience time in shorter time increments measured in the experience of digital devices. Ancient cultures may utilize agrarian time as longer planting and harvesting or positions of the planets or sun. In my lived time I may feel time passing quickly when I am having fun or

slowly when I am having anxiety.

Space in classical terms was linear units of distance which again turns out to be an abstraction. In phenomenology, space for individuals is experienced in terms of regions. We bring different regions closer or further away depending on our experience. For example, we may be wearing glasses while looking at a cup of coffee in our hand. Even though the glasses on our face are closer, we are inhabiting the region of the coffee, we bring it near in our attention. We also have cultural sacred spaces or memorial places. Marketing is an example of how regions of affectivity can play more into consumer purchasing than logical judgements of quality or even price of a product. Marketing understands lived experience as more central to who we are than logic and truth.

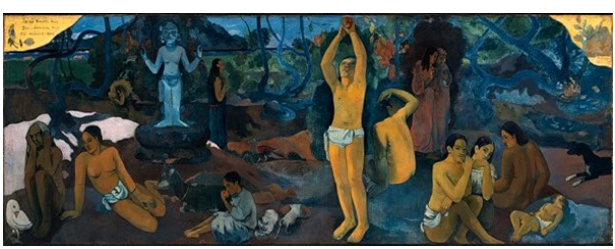
There seems to some similarities in quantum physics in which spatiality is shaped by exformation density which in wave function collapse is not merely the abstract idea of bare distance and extension but also in some spooky way participates in historic *narratives* and self-consciousness more akin to lived space, living intentionality, lived regionality, where bringing regions far and near have more to do with lived settings. Perhaps we could think of this case as the region of a theatric stage, of a play. For an audience, the stage of the play is ‘closer’ than the seats we are sitting in. It seems to me there is an element of entanglement here in which linear, abstract distance falls short - is simply abstract.

Additionally, contrary to positivism, empirical certainty obtained through the sense finds history as language which is spookily interpretive. There is no pure classical understanding of history which can be divorced from interpretation. Hermeneutics is the study of how history gets interpreted. In Greek mythology Hermes was the playful, mischievous trickster which bought messages from the gods to humans with a certain amount of embellishment. So, while we have a sense of objective truth, that sense can never be detached from interpretation and experience just as classic physics can never reach its ideal in its inventive

abstraction we simply think of as *reality*. *Reality* can only exist as an abstraction which gives us some information but can never reach the ideal of a full account of all information. As quantum mechanics shows us the record of information must always remain inherently statistical and probable.

But for what purpose? This asks the ancient philosophical question of origin which I wrote about extensively in my philosophy series on this blog. [32] The ancient answer of Hesiod to origin is chaos or 'yawning gap'. In contemporary language, chaos indicates the negation of knowledge. Contrarily, the yawning gap for the ancient Greeks indicates an incompleteness of knowledge. An excess of knowledge which cannot be measured by knowledge. Contemporaneously, this is more like what we mean by the term infinity which indicates an overflowing of itself. Even 'infinity' has a tendency to be abducted by the assumed knowledge of neutrality. I prefer Levinas' phrase radical exteriority or radical alterity.

In one form or another, the issue of the ultimate beginning has engaged philosophers and theologians in nearly every culture. It is entwined with a grand set of concerns, one famously encapsulated in an 1897 painting by Paul Gauguin: *D'ou venons-nous? Que sommes-nous*? *Ou allons-nous*? Where do we come from? What are we? Where are we going? The artwork depicts the cycle of birth, life and death--origin, identity and destiny for each individual--and these personal concerns connect directly to cosmic ones.



We can trace our lineage back through the generations, back through our animal ancestors, to early forms of life and proto-life, to the elements synthesized in the primordial universe, to the amorphous energy deposited in space before that. Does our family tree extend forever backward? Or do its roots terminate? Is the cosmos as impermanent as we are? In all these questions our historic narratives have provided an answer which has gone underground into our subconscious – absolute and unquestioned neutrality.

What would happen if we gave up the historic supremacy of the reductionist ghost of mechanistic neutrality for an exteriority in which the culmination of neutrality, quantum physics arising from classical science, has brought us to a chasm where the meta of scientific objectivity no longer suffices for common sense assumptions. 'Modern times' in which we go around and around in the cogs of neutral mechanism has shown itself in quantum physics as abstraction which can longer suffice. Yet, we go round and round transactionally deluding ourselves into thinking the one with the most toys wins. The gaping void of the 'it-ness' of Being has worn thinner and thinner where desperation and despotism scream that something has gone terribly awry with reactionaries crying against 'wokeness' as if the cultic trance has become necessity. Relativity started us toward the slippery void and co-arising with it, quantum spookiness has exposed the exhaustion of the myths which set the stage for reality and Being. Levinas refers to neutrality as the elemental 'there is' in which sunlight, wind, and rain become 'natural processes' of causality.

> Neutral existence or the there-is (il y a) denoted indeterminate nocturnal being, which gives way to the diurnal being called "the elemental" (sunlight, winds, rain). As noted, being in Levinas thus entails both dynamic forces and a conception of natural processes and causality. [34]

The sheer ‘isness’ of *phusis* as inanimate, as ‘matter’ no longer retains its title and rule as origin, as divine, as absolute in which consciousness bowing to Concept has become immanent neutrality resolving all into totality which has rid itself of self-consciousness.

> Indeterminate, nocturnal being remains ‘something’. As the “there is”, being fills in all spatial and temporal intervals, whereas consciousness arises out of it thanks to its self-originating awakening and focus. This is Levinas’ first comprehensive sketch of being as a totality, in which the self-ego dyad appears as the limited transcendence of neutral being. Over the course of his analyses, this self-ego will hearken to a call. However, the call comes not from being but from an alterity that Levinas compares with death itself. “Just as with death, I am not concerned with an existent, but with the event of alterity” [35]

Radical exteriority is *phusis* and contemporary physics disappears as the limit of chaos in the quantum wave function which physicists colloquially refer to as *universal*. But as mentioned the notion of universal, many-worlds, etc. may be a useful pedagogical tool at times but it really imposes a kind of ontology and epistemology on the quantum wave function which creates more impediments to understanding than it appears to solve. However, in the esteemed tradition of classicism and particularly Hegel, chaos shows itself as abstraction which must find concretization. From the entire history of classicism chaos can only be the ‘not’ of order. However, this ‘not’ has no excess. This ‘not’ remains a binary duality best described as disorder. Chaos as the ‘not’ of order or the ‘not’ of knowledge departs from Hesiod’s yawning gap. Isn’t this ‘chaos’ yet another form of violence and mere deference from origin? In this case, disorder is a condition of order and vice versa which really amounts to degrees of the same. Chaos in this case has been reduced to a deficient mode of order.

Historically, reductive logic has not had a great track record of maintaining its veracity over time. It seems subsequently, more times than not, there was some excess to the reduction which doomed it.

Any reductionary scheme will exhibit symptoms reminiscent of Hegel's dialectical 'not-ing' process which we are told proceeds from more abstraction to more concrete unities which hold apparent abstractions as a higher unity. Yet, the higher unity finds its 'not' upon which it shows itself as more abstract until yet again a higher more concrete unity evolves from and in these apparent abstract reductions. In this way the intermediate 'not' of reductions evolve towards higher unities which organically and immanently proceed from abstract appearances of oppositional negations to higher concrete unities. As we saw with Hegel's derivation of space and time, the neutralities of space and time increasing eventually lead to self-consciousness as a more concrete manifestation of abstractions of space and time. Hegel's process then gives an apparent solution to the problem of reductionism as a hierarchical movement towards immanent truths which, in a sense, transcend the problem of reductive binary dualities. Sceptics at the time of Hegel and even into critiques of 20th century postmodernism have argued that all these shenanigans are really simply playing with language, language games. When transitions like the neutrality of space and time pass over into self-consciousness our modernist reductions to the sense thinking machine start sounding alarms which reflect on the inappropriate use of language. The reason for this is legitimate to some degree. This is because language itself grew out of ancient intuitions, religions, superstitions, and pretenses to truth which could not stand the test of time. But even modernist truths reflecting a distrust of language and its looseness with empirical observation have also failed to account for discoveries emanating from the very bedrock of empirical positivism in the 20th century as we have seen with quantum physics. But there are other discoveries in almost all 20th century sciences including

evolutionary science which have eroded confidence and certainties in empirical observation. One such example of this directly has to do with language and its incongruity with biology.

> Avram Noam Chomsky[a] (born December 7, 1928) is an American professor and public intellectual known for his work in linguistics, political activism, and social criticism. Sometimes called "the father of modern linguistics",[b] Chomsky is also a major figure in analytic philosophy and one of the founders of the field of cognitive science. He is a laureate professor of linguistics at the University of Arizona and an institute professor emeritus at the Massachusetts Institute of Technology (MIT). Among the most cited living authors, Chomsky has written more than 150 books on topics such as linguistics, war, and politics. Ideologically, he aligns with anarcho-syndicalism and libertarian socialism. 36

Noam Chomsky believed deep and surface language structures were derivation trees of a context-free language. These trees are then transformed by a sequence of tree rewriting operations ("transformations") into surface structures. Chomsky proposed the concept of Universal Grammar, which posits that humans are born with innate biological knowledge about many features of language. This includes structures and rules that are common across all languages. According to this theory, there exists a deep structure underlying language. Outward-facing surface structures relate to phonetic rules (how sounds are produced), while inward-facing deep structures relate to words and conceptual meaning. At the heart of Chomsky's theory lies the innateness hypothesis. He suggests that we come into the world primed to learn language. This hypothesis is anchored by the concept of Universal Grammar, a built-in set of grammatical structures inherent to all human tongues. Chomsky proposed that the first stage of language development occurs immediately upon birth. Infants, though

preverbal, possess an innate language acquisition device. The language acquisition device sets them up for language development, allowing them to acquire language effortlessly and consistently across cultures. Two striking features of language are:

- Diversity: We do not all speak the same language.
- Constraints: Most languages cluster in a few tiny bands, showing more similarity than random variation would predict. 37

Chomsky's theory aims to explain these features by positing a deep and underlying structure shared universally across languages. Evidence supporting this idea comes from studies showing that children understand syntactic categories even before they express them in their own speech. Chomsky's linguistic theory is rooted in biolinguistics. Biolinguistics asserts that the principles underlying language structure are genetically inherited and preset in the human mind. Just as our organs develop as we mature, language also emerges as a species-wide trait. The innate language faculty knows the rules, allowing children to acquire language, while vocabulary and specific language details are learned. 38

In complementarity, just as quantum particles exhibit both wave-like and particle-like behavior, the wavicle, language structures can be viewed from different perspectives (deep vs. surface). Quantum entanglement involves non-local correlations between particles. Similarly, linguistic elements (such as words or phrases) can be entangled in complex ways. Quantum superposition allows particles to exist in multiple states simultaneously. Analogously, linguistic elements can have multiple interpretations or meanings. Studies in the area of linguistics and quantum mechanics have some interesting possibilities. Research is beginning to increase rapidly in many areas involving macro-oriented phenomenon and quantum physics. Much of this research is also spawned on by developments in artificial intelligence and quantum

computing known as quantum intelligence. [39]

Chomsky's theory has intriguing parallels with the quantum wave function. His theory, as for the wave function, blurs the inherited line we get from modernist histories which cleanly divide biology and linguistics. The result is that linguistics tends to get swallowed up into a reduction to the mechanics of biology. The wave function does not allow for such linguistic distinctions in reductions to mechanism. Chomsky's theory also blurs lines between individual and collective as does the branching of the wave function into classicism implicating the brain, consciousness, language, chemistry, biology, evolutionary science and many other disciplines. As with quantum biology, many sciences are getting more and more integrated with quantum physics; we can expect this kind of trend to continue. The premature summation and reduction of the self, the 'my' of self-consciousness, has exasperated itself in modernism.

Exformation Again

Resistance to change is the tendency set up by our uniquely human capacity to already be historic, to already orient ourselves phenomenologically from an all-encompassing narrative. This narrative is shortened in such a word as 'reality' and such actions as practicality. Philosophers call these reductions originating from the historic tradition ontology. Yet now we have physics which has told us in no uncertain terms that at the most fundamental level - reality has no certain state, no 'Being' or even existence. And to add insult to injury there is a spooky relation to observation and complexities which pass into chaos. This is not some wild-eyed Democrats conjuring up the breakdown of social norms. This is physics telling us that 'reality' is necessarily uncertain and has an uncertain dependency on what we are looking for observationally. Furthermore, we shall not call these extremely different observations contradictory, we shall call them euphemistically

complementarity. Call it what we may, it wildly exceeds any historic ontological understanding of Being or essence.

What we see is not enduring when we are not observing. This does not mean 'reality' disappears. That would simply be the negative case of the conventional notion of reality which appears in our history. In that case, we simply reaffirm our historic narrative in its denial. Doing this exercise simply shows itself and 'all things' as 'objective reality' OR 'absurd', 'ridiculous', 'nutty', etc. In making these assertions we simply reaffirm our unwavering confidences in historic narrative. Exformation is very different from our historic narratives. Exformation has no origin, no cause. Exformation has no allegiance to our historic narrative of some 'objective reality' which exists apart from 'my subjectivity'. And neither does it fall into the contrary category of senseless, meaningless, pure psychic hallucinations of absolute subjectivity. These simplistic binary dualities which must of necessity feed upon themselves are reductionary and ultimately shut down thinking as a kind of hermetically sealed environment.

Regarding the absolutes of objectivity and subjectivity, exformation even takes an extraordinary step away from our lived historicizing phenomenology. Exformation breaks down our classic notions embodied as 'absolute'. From this perspective, the absolute then becomes an artifact of a certain anthropology of the West. Information now necessarily includes exformation which can find no place in our 'common sense' culture. The wave function's branching into classicism necessarily means a loss of information called decoherence which cannot be recovered. We think of this simply as the 'existence' of particles.

> First, according to quantum theory, at some point the naive notion of reductionism, in the sense that emergent properties of higher layers of description can be at least in principle explained by the properties of isolated constituents, breaks down, as the mere existence of these constituents itself turns

> out to be a consequence of isolating the corresponding degrees of freedom from their environment. In other words, the existence of particles is a consequence of a specific perspective: Whenever a particle is observed, the quantum field gets coupled to the measurement device and its unknown environment. It is this interaction and the information loss that implies that the state of the quantum field is observed as a particle. Particles thus are a consequence of decoherence. Particles are, as Zeh argues consistently, emergent themselves (in the sense that a description in terms of constituents neglects information about the entangled total system). [40]

To add insult to injury, this loss of information in branching is directly related to observation. Classicism has conceived 'reality' based on an assumption that: 1) what is real is fully accessible in some type of information whether it be empirical, philosophical, religious, etc. and 2) observation is independent of reality. Heinrich Päs is a professor of theoretical physics at TU Dortmund University in Germany. In his paper entitled "Physics Beyond the Multiverse: Naturalness and the Quest for a Fundamental Theory" [41] he makes some excellent points about quantum physics and what we might mean by *fundamental*. I highly recommend reading this especially, pages 8 through 12 of the .pdf. Typically, and from a classical perspective, by fundamental concepts or realities we mean observer independent. But in quantum physics there is no *independence* of the observer. Each observer has a unique and *unanimous* perspective. And what does 'classical' even mean when a definite result applies to one Everett branch? Päs remarks,

> As has been argued by Werner Heisenberg in 1932 [38], the protons and neutrons constituting the atomic nucleus behave so similar that they can be understood as two states of a single particle – in analogy to a quantum spin which can

> point up and down. Heisenberg thus described proton and neutron together as the two possible states of an isospin doublet. Curiously, this way the apparent material difference of proton and neutron is reduced to the information about the state of the isospin Q-Bit. [42]

Päs gives some very good examples of how the determination of fundamentals runs into roadblocks in quantum physics. Nevertheless, there are elements in quantum theory of a materialistic component. The spooky notion of locality makes any such classical orientation to 'fundamental' difficult. Päs concludes that,

> Thus the fundamental state of the Universe can not be a constituent, it has to be the total entangled system of observer, measured system, and environment, also known as the quantum Universe itself. [43]

He also remarks that decoherence, everything we supposed from classicism, is a *lens* not a reality. And this lens is adjusted and custom-fits the eye of the historic beholder.

This quandary leads us inevitably back to consciousness and self-consciousness as somehow indispensable to our notion of reality and also somehow implicated in the spooky quantum riddle of the wave function.

What is Consciousness?

Here is a question that the history of science, philosophy, and religion has asked and answered in many ways but remains, what is consciousness? Is consciousness purely contingent? Is self-consciousness arising from the human history of reflection uniquely or is it common to some or all mammalian and/or biological life? Is consciousness simply an adaptive, evolutionary trait of Homo

sapiens? Perhaps consciousness has degrees of self-awareness for other species. Is self-consciousness absolutely unique and non-contingent? Is consciousness, the soul, a gift from God? Is Being onto-theological or ontological? For Heidegger, Being would be ontological, a unique kind of questioning aroused by and arousing the 'there of being', *Dasein*, which must co-arise as the emergent and emerging of beings. This is what Heidegger refers to in his later writings as the 'sway of being', the event of appropriation? Is the fascination of self-consciousness much ado about nothing? Are we simply cogs in a "Modern Times" machine of Chalie Chaplin?[44]

Certainly, modernity has exacerbated this ludicrous scenario. In the universe of absolute space and time where cause and effect rules absolutely, all of these questions dance upon the field of historic consciousness. Currently, there is a prevalent resignation to finding 'joy' in simply reducing consciousness to mechanism. This paints life and the universe from the canvas of modernity's metaphysical, sense-driven, cause and effect, reduction originating from classical physics. These modernist truth-values have been eroding from at least the beginning of the 20th century. Quantum physics has ushered in a new *phusis* which places historic physics, along with all histories of sciences, philosophies, and religions built on modernism, as a very limited case of a universe which never existed as it was imagined – as merely boundary and membrane taken in the narrative of absolute.

Consciousness is self-awareness. Self-awareness is not based on a subject separated from objects. The self is an entangled quantum system. Entanglement is not solitary, finite, and bound in a universe of cause and effect in spacetime. Entangled systems are not boundaries in the binary way we think of them. Boundaries can be artificially drawn in the process we call renormalization providing us with practical applications like qubits. However, unless one is the metaphysical Laplace demon, infinites are what make the quantum world so complicated.

What makes it [quantum field theory] so complicated for mathematicians? In a word, infinity.

When you measure a quantum field at a point, the result isn't a few numbers like coordinates and temperature. Instead, it's a matrix, which is an array of numbers. And not just any matrix — a big one, called an operator, with infinitely many columns and rows. This reflects how a quantum field envelops all the possibilities of a particle emerging from the field.

"There are infinitely many positions that a particle can have, and this leads to the fact that the matrix that describes the measurement of position, of momentum, also has to be infinite-dimensional," said Kasia Rejzner of the University of York.

And when theories produce infinities, it calls their physical relevance into question, because infinity exists as a concept, not as anything experiments can ever measure. It also makes the theories hard to work with mathematically.

"We don't like having a framework that spells out infinity. That's why you start realizing you need a better mathematical understanding of what's going on," said Alejandra Castro, a physicist at the University of Amsterdam.

The problems with infinity get worse when physicists start thinking about how two quantum fields interact, as they might, for instance, when particle collisions are modeled at the Large Hadron Collider outside Geneva.[45]

In quantum physics boundaries are windows on infinities. Self-awareness could be thought of as a term to describe highly entangled quantum systems with boundaries from the observe effect. But these boundaries entangled with us are entangled with other systems near and far (in the classical way we think of near and far) in spooky ways as wavicles with chaotic and complex field infinites. Self-awareness, awareness, self-consciousness,

consciousness, are all ‘renormalized’ systems which history defines as bodies, minds, etc. The observer effect has some spooky *phusis* effect with informational branching which makes the classical idea of cause-and-effect, things going bump in the night, an outdated nursery tale we tell ourselves. Wave function collapse by observation or spontaneous collapse certainly underlie anything we think of as awareness of awareness. Aristotle’s awareness of awareness to be discussed a little later in the section entitled “The Unmoved Mover” is not some metaphysical Latin soul but something much stranger. Whatever we think of as the boundaries, membrane of ‘me’, my body, etc. are extremely dynamic and unpredictable windows upon unimaginable infinites. Quantum physics is a call to consciousness, to spooky observation, to wake up and view the precipice which stares back at us.

Sensibility, from the senses, was the motif of modernity. Sensibility is still what guides much of 20th century philosophy. Alternately, sensuality is not merely erotic. Sensuality is kinesthetic. Sensuality in the broader sense is affective. Sensuality comports us toward ‘how we feel’ and orients us in our lived existence. Sensuality ranges from the caresses of our loved ones to the horrid and tragic deaths of those we love in our lives. It ranges from the driving determinations of security to the hollowing out and emptying out of our insecurities. Sensuality does not exclusively harken back to the existentialist determination of the angst of existence, of the entrapment of sensuality in sensibility, in existence. Rather, from the exhaustion of modernism based on sensibility, the abstractions of the thinking machine which senses its way through existence, to having arrived before and inherent in the phenomenologically sensual way we concretize our ‘lifeworld’. How do we ‘feel’ ourselves in spacetime? What is the dynamic of feeling our way through life and the interaction with how we think or narrate ourselves, our history, our being in the world? Where is the sensual breakdown thrust upon us starting with the reevaluations of relativity and moving towards chaotic non-causal exformation?

How can ‘the good’ have anything to do with chaos? What would it mean to try to think of externality which cannot be recuperated into our common sense, our history of language and culture which determines the narrative of common sense, of practicality? Husserl was one of the first philosophers to seriously undertake the seismic consequences of the early 20th century. Husserl introduced the term lifeworld in 1936 with his publication of “The Crisis of European Sciences and Transcendental Phenomenology”.[46]

> In whatever way we may be conscious of the world as universal horizon, as coherent universe of existing objects, we, each "I-the-man" and all of us together, belong to the world as living with one another in the world; and the world is our world, valid for our consciousness as existing precisely through this 'living together.' We, as living in wakeful world-consciousness, are constantly active on the basis of our passive having of the world... Obviously this is true not only for me, the individual ego; rather we, in living together, have the world pre-given in this together, belong, the world as world for all, pre-given with this ontic meaning... The we-subjectivity... [is] constantly functioning.[47]

For Levinas, consciousness reduced into the boundaries of ‘thinking’ must always turn back on itself. From my perspective, thinking turned back on itself can never find certainty only continual deferment as the basis for transactionalism. Thinking turns back on itself because the Other (Autrui), the she or he which faces us, is,

> Immemorial, unrepresentable, invisible, the past that bypasses the present, the pluperfect past, falls into a past that is a gratuitous lapse. It can not be recuperated by reminiscence not because of its remoteness, but because of its incommensurability with the present. The present is essence

> that begins and ends, beginning and end assembled in a thematizable conjunction… [48]

Perhaps later we will see that love is the trace of externality. Love overtakes us, interrupts us, draws us towards the Other (Autrui) without totalizing the Other (Autrui). The play of my freedom cannot *a priori* take account of exteriority. Memory cannot call love to presence. My subjectivity is the call to account for the Other (Autrui) which I cannot account for. The null site of subjectivity is 'me' which must retreat from exteriority. 'Me' as without recourse is hiding in the cleft of the rock. I cannot face the Other (Autrui) in his or her externality as if from some mystic, ecstatic, experience. I can only exist as the aftermath, the residue as subjectivity, as never knowing and yet held to account as the haunting which, like waves on the shore, beats against my subjectivity. Here again we arrive at ‘’*epekeina tês ousias*’’ or ‘the good beyond being’. All of this will be discussed later.

Phusis or epoch begins with chaos, indetermination, uncertainty and through the centuries acquires certainty in truncation as practical common sense. Now at the end of our epoch we once again for the first time face uncertainty that is stripped bare of any language to reaffirm and found our epoch or perhaps any epoch. We are speechless before the abyss ‘to be able to be able’. Yet the Other (Autrui) still speaks to us in a still small voice from an unbreachable abyss. What is it that all this time we have not heard? Even in Husserl’s epoché, the bracketing, where consciousness thinks back and forward from its living past and future finding the living present, the internal [lived] time consciousness is sensation congealing in spontaneous regeneration of time as retention (what is dynamically retained as the living past) and protension (what is projected towards the living future).

Husserl calls this time consciousness lived protension and retention. Phenomenology recognized the breakdown of modernism and historic abstractions. It sought to return meaning-bestowing

back to life as we live it not as the empty abstractions of history. According to Husserl, phenomenology aims to clarify the constitution of transcendence. In other words, it seeks to understand how consciousness constitutes and relates to objects beyond itself. The term transcendental in Husserl's context refers to several interconnected aspects:

- It signifies the exceptional status of rationality—the philosophical attitude that allows us to explore the relationship between the knower (subject) and the known (object).
    - It encompasses the methodological approach and language used by philosophers engaged in this exploration.
    - Importantly, Husserl's use of traditional terms was far from conventional. His conception of the transcendental differed significantly from the traditional understanding. [49]

One key aspect of Husserl's approach is the transcendental-phenomenological reduction. This reduction uncovers the ego, revealing the foundational level where everything gains meaning and existence. Simultaneously, it transforms the world into mere phenomena, emphasizing the subjective experience and intentional acts of consciousness. Husserl's transcendental philosophy is lived subjectivity and consciousness and how it constitutes reality. [50]

In Husserl, time is in no wise associated with the time of classical physics. Husserl's relativity finds some commonality with Einstein's continuous and relative frames of spacetime but also very different, not as the domain of physics but as lived space and time. In a way, sensualism in Husserl is compatible with the epistemological doctrine of empiricism which holds that all pure rational cognitions are derived from the senses. However, Husserl

finds no ‘senses’ of cause-and-effect relation to sensual intentionality but to the surprise and spontaneity of lived internal time consciousness. Husserl finds no such possibility extreme externality can enter into internal time consciousness. In this rather difficult passage for folks that are not steeped in Husserl, Levinas writes,

> In Husserl internal time consciousness, and consciousness as such, are described in the temporality of sensation: “sensing is what we hold to be the originary consciousness of time,” and “without the impression consciousness is nothing.” Time, the sensorial impression and consciousness are put together. Even at this primordial level which is that of lived experience, in which the flow, reduced to pure immanence, should exclude even any suspicion of objectification, consciousness remains an intentionality, an “intentionality of a specific kind,” to be sure, but unthinkable without an apprehended correlate. This specific intentionality is time itself. There is consciousness insofar as the sensible impression differs from itself without differing; it differs without differing, is other within identity. The impression is illuminated by “opening up,” as though it plugged itself up; it undoes that coincidence of self with self in which the “same” is smothered under itself, as under a candle extinguisher. It is not in phase with itself; just past, about to come. But to differ within identity, to maintain the moment that is being altered, is “protaining” and “retaining”! Differing within identity, modifying itself without changing, consciousness glows in an impression inasmuch as it diverges from itself, to still be expecting itself, or already recuperating itself. Still, already — are time, time in which nothing is lost. The past itself is modified without changing its identity, diverges from itself without letting go of itself, “becomes older,” sinking into a deeper past: it remains identical with

itself through retention of retention, and so on. Then memory recuperates in images what retention was not able to preserve, and historiography reconstructs that whose image is lost. To speak of consciousness is to speak of time. [51]

It is in any case to speak of a time that can be recuperated. At a level which for Husserl is originary, temporality involves a consciousness that is not even intentional in the "specific" sense of retention. Despite the complete overlapping of the perceived and the perception in the Ur-impression, the originary or primal impression, which ought to no longer let the light pass through, despite their strict contemporaneousness which is the presence of the present, despite the non-modification of this "absolute beginning of this generation — the primal source, that from which all others are continually generated," this today without a yesterday or a tomorrow — the primal impression is nonetheless not impressed without consciousness. Does not the originary impression "non-modified," self-identical, but without retention — precede every protention, and thus precede its own possibility? Husserl seems to say this, in calling the "primal impression" the "absolute beginning" of every modification that is produced as time, a primal source which "is not generated" and is born "**through spontaneous generation**." "It does not grow up (it has no seed); it is primal creation." Would not the "real" that precedes and surprises the possible be the very definition of the present, which in this description is indifferent to protention ("generation has no seed!), but would nonetheless be conscious of it? That is certainly the most remarkable point of this philosophy in which intentionality "constitutes" the universe, the prototype of theoretical objectification commands all the modes of intentional positing, be they axiological or practical, and in which in every case a rigorous

parallelism between the doxic, axiological and practical theses is constantly affirmed. Husserl will then have liberated the psyche from the primacy of the theoretical neither in the order of know-how with equipment nor in that of axiological emotion, nor in the thought of Being, different from the metaphysics of entities. Rather, objectifying consciousness, the hegemony of re-presentation, is paradoxically surmounted in the consciousness of the present. And this makes understandable indeed the underlying or commanding importance of the still so little explored manuscripts concerning the "living present" in the whole corpus of his research. Though it be a rehabilitation of the "sensorial given" of empiricist sensualism, the primal impression finds again in the context of intentionality (which for Husserl remains all-encompassing) its power to surprise. Through the notion of the living present, the notion of origin and of creation, a spontaneity in which activity and passivity are completely one, tend to become intelligible. When it turns out that this consciousness in the living present, originally non-objectifying and not objectified, is thematizable and thematizing in retention, without thereby losing the "temporal place" which gives "individuation," then we see the non-intentionality of the primal impression fitted back in the normal order, not leading to the hither side of the same or of the origin. Nothing enters incognito into the same, to interrupt the flow of time and interrupt the consciousness that is produced in the form of this flow. A putting the self-identity of the living present out of phase, a putting of the phases themselves out of phase, in the intentionality of retentions and protentions, the flow looks like a multiplication of modification dispersing from the living present. In Husserl the time structure of sensibility is a time of what can be recuperated. The thesis that the non-intentionality of the primal retention is not a loss of

> consciousness, that nothing can be produced in a clandestine way,what nothing can break the thread of consciousness,excludes from time the irreducible diachrony whose meaning the present study aims to bring to light, behind the exhibiting of being. [52]

Rather than being a metaphor taken from the movement of waters in a river, would not flowing be the very temporality of time and the “science” of which “consciousness” (conscience) is made? To speak of time in terms of flowing is to speak of time in terms of time and not in terms of temporal events. The temporalization of time — the openness by which sensation manifests itself, is felt, modifies itself without altering its identity, doubling itself up by a sort of diastasis of the punctual, putting itself out of phase with itself — is neither an attribute nor a predicate expressing a causality “sensed” as a sensation. The temporal modification is not an event, nor an action, nor the effect of a cause. It is the verb to be. (Levinas, Otherwise Than Being or Beyond Essence, 1981, p. 100)

Note that this passage in Husserl has nothing to do with some modernist notion of subjectivity. I hope the reader can at least get a flavor from this rather long passage about how Husserl has much more to do with the early 20th century than what came before. Nevertheless, in any case, Levinas still believes internal time consciousness rests comfortably in the nascent certainty of ‘to be’ even without the necessity of causality. The divergence of causality from consciousness in Husserl shares a contemporaneous 20th century history with the founders of quantum mechanics.

In quantum mechanics, cause has been lost to exformation. However, exformation is not merely a physics of disembodied objects. Even in quantum physics the self, ‘me’, is an entangled quantum system. Certainly, there is quite an abyss between quantum entanglement and Levinas’ radical alterity of the Other (Autrui). However, one important idea they share is that ‘me’ is not produced in the totality of ‘to be’. Another unsettling idea they

share is that all that is certain only vanishes in the misty haze of spooky uncertainty, something which can find no return to itself as essentiality or even sensuality of certainty. In the quantum wave function the observer does not die as history would have it. Information is updated. Could it be that lifeworld branches in some spooky, indeterminate way?

Death is a historic myth we tell ourselves to anesthetize the pain of life, the suffering of old age and tragic loss of our precious loves. We do not die in glory, in Being, as Nietzsche's heroic figure. We die in pain and suffering without any recourse. We die in weakness, absolutely unable to be able. We do not actively and heroically conquer death. Death conquers us. Death lays us waste in weakness and suffering, tragedy, and insufferable loss. We are not challenged by authenticity to be resolute in [towards] death. As Buddhism teaches, life is suffering not glory. Glory is a fiction thrust upon us in abstraction. We yearn for glory but in life we endure tragedy, remorse, pity, and guilt. Virtual reality lives in the possibility of glory and dies in the reality of existence. So, we need to look at death in terms of how our abstractions of it pacify our sensibilities but open a gaping void in our sensuality.

Certainly, we will die but to believe that a mechanistic, reductionary, absolute finality is more than a historic myth we tell ourselves is to make assumptions which harken back to the non-spooky, the quickly dimensioning historic avenues which desperately desire to transform the spooky into the dying same. I want to briefly skip ahead at this point to introduce some thoughts of Levinas in this regard. One important relevant point to make here is that Levinas is not the stereotypical type of philosopher who is all brains and no feeling. To the contrary, Levinas cannot be understood without knowing his approach to philosophy is arriving to us from our sensual relation to the other and the world. What lurks behind the scenes when we measure sense data over lived embodiment and the way we sensually interact with the world and others?

A DIFFICULT BEGINNING

First, let me state that Levinas and Hegel are by far the most difficult philosophers I have ever read. While they are very different from each other, their words are incredibly compacted, rich, and borrow heavily from the history of philosophy. I have already elucidated very simple, probably too simply, some of my issues with Hegel. However, Hegel is not the direction in this book except to point out some histories of philosophy and some problematic differences in 20th century philosophy with Hegel. With Levinas, I am going to try my best to unpack his ideas, but I will also be working through it yet once again with you while I write. Nietzsche once said that he could write in more in an aphorism than most other philosophers would write in an entire book. While Levinas is also very different than Nietzsche, he does seem to share that quick and concise wit.

I have gone much of the way through this book with a bit of angst and a lot more reading of Levinas knowing that there is an important link to the previous discussion of physics but not specifically knowing how I am going to convey this in my writing. The beginning here will not be easy for the reader but anyone that might have ventured thus far must already be acclimated to such a task. This beginning will be difficult and risks becoming murky. The only solace here is that after the beginning I will try to build more slowly from the history of philosophy already explored which finds its apex and final stand in the 20th century. For now, let's try to make a probably too hasty beginning.

I want to start this major section with a difficult piece by Levinas. Levinas is not an easy philosopher to read. His thoughts are densely packed with a rare breed of scholarly knowledge of the history of philosophy. Additionally, Levinas was not content to be merely academic. Perhaps part of this could be attributed to his imprisonment during the holocaust. However, I find his orientation to also recognize the postmodernist dilemma which has brought us

face to face with the exasperation of classicism. But unlike many postmodernists and beyond, Levinas brings us face to face with the Other (Autrui), the people we face every day, in a highly insightful reckoning with the void we cannot turn from. In this abyss Levinas, in a similar way to the spookiness of quantum physics, brings us to a difficult thought, an awkward inability to be able, to find an easy historic and commonsense answer. Levinas wants to bring us face to face with the Other (Autrui) as radical alterity not merely the 'thing' as other which can still find echoes in the paradigm of even quantum physics. However, unlike physics, radical alterity is not 'spooky' but rather is responsibility to what cannot be brought under my auspices, my narcissistic echoes which simulate the Other (Autrui), dilute the Other (Autrui) as simulacrum, as image and representation in which responsibility is optional, based on my freedom to mold the Other (Autrui) into my own image.

The long quote I will get to near the end of this section will be cryptic and difficult to understand without a more comprehensive background in classical, modern, and postmodern philosophy. But I do not do this to intentionally aggravate the reader. My hope is to offset the awkwardness of this quote with simply a sense of a song in Levinas' style. I will get into the details of this quote later, but I think that in reading with a feeling of chaos, the inability to be able to situate meaning readily may also bring a bit of intrigue in the way that music provokes without comprehension. If the reader can first get a sense of richness of possibilities in Levinas' thought along with a feeling of some excess, some externality, which elicits a sense of what was always intended but never quite grasped – beauty, wonder, and awe in already being indebted before the 'I' can be *said*, then the abrupt departure into this difficult beginning will be worth it. But before the long quote I want to make a few preparatory remarks.

We not only 'live' the world, but we also feel the world. Levinas writes of love, fecundity, eros, desire, the caress, paternity, suffering, death, insomnia, and other lived feelings. Part of this is

because of his background in phenomenology and lived experience but beyond that Levinas wants us to understand that we encounter the Other (Autrui) sensually. Philosophers tend to write descriptively even when they reflect on sensuality. However, that is not how we experience ourselves. I encounter others with feelings whether it is retreating such as anger, fear, insecurity, guilt, remorse or attraction as love, concern, intimacy, touch, etc. Even indifference to others is an emotion of solitude, withdrawal, or retreat. Hate, dislike, bigotry, and intolerance are emotions which cling to a concept of the despicable or evil other. These emotions take no time for factuality or critical thought. They retreat into a fictional narrative reductive of the other. They isolate and withdraw either in solitude or in the company of those who validate and devote themselves to the project of fictionalizing the other. There is no other in hate. There is only me and mine. Love and ownership of the Other (Autrui) cannot exist in the same lived space.

Love is a vulnerability to the other. It is an intentional opening of myself to the otherness of the other. It resists and refuses consolidation of the Other (Autrui) into a persistent thought of the Other (Autrui). From risk, love allows and welcomes the Other (Autrui) to break through the plastic castes of their face which Concept, Being, totality, and idea want to universalize. The fictions we cast upon the other are intently allowed to shatter responsibility for my loves, my wife, my child, my friends, strangers, and even my enemies. Love suffers long and believes steadfastly not for the sake of love itself but for the other, the one I love from indebtedness and responsibility. Love does not affirm ‘me’ as Narcissus’ echo. Sensual intimacy which languishes in self-satisfaction is masturbation or auto-affection. Auto-affection cannot survive the otherness of love, the vulnerability of love. Writing of an important early work of Levinas called “Totality and Infinity” Todd McGowan writing of love states,

Levinas speaks of the importance of avoiding ‘fusion’,

> ‘possession’ and ‘knowledge’ in love. In Totality and Infinity, he writes: ‘Love is not reducible to a knowledge mixed with affective elements which would open to it an unforeseen plane of being. It grasps nothing, issues in no concept, does not issue, has neither the subject-object structure nor the I-thou structure. Eros is not accomplished as a subject that fixes an object nor as a pro-jection, towards a possible. Its movement consists in going beyond the possible’.[53]

For the most part, Levinas makes a distinction between sensibility and sensuality which I will also try to maintain in this text. Sensibility is given from the modernist senses. I have already spent much time in this book bringing to the fore how classicism and modernism reductively has given us the persistent narrative of ‘practicality’ which validates and sanctifies ‘common sense’. Let’s return to the historic narrative of death which is shaken to the core by our sensual forebodings and uncertainties as radical externality. Can we begin to think about exformation and where that might lead us?

As I will try to explicate, Levinas wants to turn away from almost everything we have already covered in the history of philosophy. He wants us to sensually make apparent to ourselves how our philosophical inheritance tends to practically determine contexts of our sensual lived experiences. In particular, how do Being, ‘reality’ and existence already efface the Other (Autrui)? He wants to ask us, to ask ourselves, a really important question. What if the inexplicable gap we now face has a face, the face of the Other (Autrui), which the history of thought cannot account for? What could that possibly mean? What if the self is not its own? What if the self does not arise in spacetime from sensibility and fundamentally even lacks its assumed presence upon reflection but rather, sensually towards radical exteriority, the Other (Autrui) who escapes our knowledge? What if there is an unaccounted-for excess in sensuality which somehow makes it unaccountable to sensibility?

Rather, could it be that sensibility has always already been accountable to sensuality?

The rupture of the Other (Autrui) in Levinas is not a smooth transition from phenomenology. Phenomenology wants to impartially observe, to bracket, all presumptions from science, philosophy, and religion. For Husserl any science or philosophy which would not bracket its assumptions whether it be assumptions of objectivity, subjectivity, time, space, rationality, etc. could not be a complete science. Therefore, he thought philosophy should be the science that must account for how we first, individually experience phenomena without presuppositions and second, how these phenomenological observations make any such thing as a lifeworld possible. In this way a phenomenologist is more like a clinical psychologist without theoretical psychological presumptions. Phenomenology would incorporate all the ways we encounter phenomena by holding at bay presumptions and getting back to what shows itself. Levinas cannot maintain the 'showing' of the Other (Autrui), the he or the she, because the Other (Autrui) cannot come to presence or absence. It must exceed logical oppositions and hierarchies which unify them into consciousness and unconsciousness, presence and absence. In Levinas, the externality of the Other (Autrui) cannot 'give account', be brought under auspices of senses into commonsense. But neither can science find a rational basis for the spooky behavior quantum entanglement. Why not use this conundrum in science as a hint for what philosophy must face?

The realistic problem here is that Levinas gets taken as yet another metaphysics or validation of religion in some way. Levinas is fully aware of this danger. His writing is so dense partly because he wants to demonstrate his acute awareness of this susceptibility to his philosophy. At the same time, he wants to show that the history of metaphysics as a history of Error was subducted away from a kernel of the Other (Autrui) which it could not account for. The history of war is the history of religion, metaphysics, philosophy,

and rationalism. These traditions lacked an excess to totality. They lacked the alterity of the Other (Autrui). Instead of excess, alterity has been translated in popular culture as alien, as evil other, as monstrous to be abhorred. This has been done in spite of the admonition of Judaism for the sojourner, the immigrant, the stranger. Even in Jesus' compassion and care for the sojourner, we see in current politics that the immigrant has been transformed into the evil drug peddling 'illegal immigrants'. A clear example of this is popular culture's reaction to encouraging diversity. Diversity is seen in the mantra of 'wokeness'. Why is this? Is this because logic, origin, and totality has lost its faith? Or because logic, origin, totality congealing into commonsense has won the day.

* Logic - The other is evil by virtue of being other to the same.
* Origin - Underneath the covers of this logical binary truism, the origin of the 'other' is my idea of the other.
* Totality - My idea and origin of the other as evil, as unacceptably 'different' has everything to do with me without any possibility for an other exterior to the totality of my echo.

Even the 'difference' in the sanctified same and the profane other is preserved under an absolute pretention to 'logic'. If the same is good, the other is evil. But both come under the absolute assumption and reduction to the other as idea, as my idea. In this case, there is no excess to my idea, my logic, my adherence to popular politics. This incessant insistence has become a totality which actually preserves its inaccessible agenda to mindlessly exclude anything other than itself, its logic, its 'idea'. This obsessive insistence hermetically seals itself off from even the possibility of an excess to its sameness in the idea of the 'other'. Feigned religious altruism as morality has become a strategy to divert accusation, persecution, and self-doubt so as, in popular culture, to have nothing to do with guilt and remorse for leveling off and totalizing the other into my idea of the evil other.

Washing my hands of the suffering of the other depends on a self that is hermetically sealed in itself. If I am solitary, absolutely identical to my thoughts of myself, there is feigned equality between me and the other in which I emerge as the hero putting to waste the foe. All this is sanctified by the vernacular of transactionalism. This is the self as solitary, as absolute identity masquerading under the banner of 'me' and my notion of the other. This equality might be thought of as the basis of my branching from supposition in my hermeneutic, my interpretation, of myself as absolute freedom. My duty and obligation to the Other (Autrui) is conceived as equality, defined in terms of binary dualisms of inequality with the bad faith other. Even more, I get to be the judge of what 'equality' means. If the other is lazy and ignorant, 'me' as equality of the 'I' with the other, has judged, in the sanctity of its freedom, how *my* truths of equality and its necessary counterpart – inequalities, are drawn. But what if the Other (Autrui) is not in the self's field of freedom? What if the Other (Autrui), the he or the she, cannot come into presence or even absence in my freedom, my truths which have nothing to do with radical externality but everything to do with Narcissus? What if the other is not equal to my field of freedom but prior to it. By "prior to it" I do not even mean in phenomenologically 'my' lived time, 'my' lived space, 'my' freedom, but as not commensurate in my memory or my common senses or even my sensuality which rest heavily upon the totalities of history, culture, and language. Levinas refers to this as notion as diachrony. Levinas describes diachrony as,

> Immemorial, unrepresentable, invisible, the past that bypasses the present, the pluperfect past, falls into a past that is a gratuitous lapse. It can not be recuperated by reminiscence not because of its remoteness, but because of its incommensurability with the present. The present is essence that begins and ends, beginning and end assembled in a thematizable conjunction; it is the finite in correlation with a

> freedom. Diachrony is the refusal of conjunction, the non-totalizable, and in this sense, infinite. But in the responsibility for the Other, for another freedom, the negativity of this anarchy, this refusal of the present, of appearing, of the immemorial, commands me and ordains me to the other, to the first one on the scene, and makes me approach him, makes me his neighbor. It thus diverges from nothingness as well as from being. It provokes this responsibility against my will, that is, by substituting me for the other as a hostage. All my inwardness is invested in the form of a despite-me, for-another. Despite me, for-another, is signification par excellence. And it is the sense of the "oneself," that accusative that derives from no nominative;9 it is the very fact of finding oneself while losing oneself. 54

Diachrony, the inability to synchronize temporalities, cannot come into my field of freedom where the other is a cog in a machine of 'my-selves'. This machine synchronizes all its parts into an assembly, a cog in. "Modern Times", a local realism ordered by me. The effect of this is to make all the parts, the 'selves', into pieces which have their place, their time, and accountability to my judgements of how all this works. the Other (Autrui) as "*Immemorial, unrepresentable, invisible, the past that bypasses the present*" does not include me as the arbiter and assembler of all the parts, as Dr. Frankenstein. The other has a time that is not or ever was my time, a space which any space of mine could ever inhabit. There is a gap which cannot be spanned nor recalled by my memory. How can the self, 'my-self', be undone as the arbiter of freedom which is optional and co-equal to responsibility? Am I the sole judge of my responsibility to the other as if I am the origin of the other? Ultimately, Levinas tracks this down as force, as violence to the other. For Levinas, one hint of this force is in a sensual mode which is absolutely incommensurate, irreconcilable, with the identity of the self as pure freedom. This violence is rooted in the

sensuality of obsession especially exhibited in the state of insomnia.

Obsession with insomnia finds no end in itself. It cannot take leave of itself. It can never rest. It must ceaselessly feedback upon itself with absolutely no hint of resolve. It makes 'reality' into cardboard where nothing can be but must be. It is inexhaustible thinking which has no end or no origin but only thinking about thinking itself which is unable to lose itself, to sink into oblivious sleep. It can only mock rest as yet another thought. Obsession undermines any such sense or sensibility of 'my-self', as absolute origin. No sense can be made of obsession. The self must historically rest on sense and sensibility. However, such a history as self, myself, finds no place, no rest in obsession. From this analogy, Levinas wants to show how even in the chaos of obsession without the hope of resolve there is a pure signifyingness which is endemic to both signifiers and signified which can find neither. This is not nothingness. Even in this abyssal chaos of pure signification without any object there is a saying which cannot be said, a passivity more passive than all passivity, an inability to be able. Why? Because the radical alterity of the Other (Autrui) can find no origin, no *place* (or time) to lay his or her head, no essence of Being of classicism but only responsibility for what cannot come to the fore remains. Additionally, when Levinas writes "passivity more passive than all passivity" instead of thinking of this as an encrypted statement think analogously of the quantum wave function. The ego is not the self. As we will see, the ego is the retreat from self. The ego is a refinement of a history which is the identity of the 'I'. Identity is a topic we discussed earlier. It is the basis of tautology. It is the basis of logic. It is what necessarily must be true. The 'I' of identity is defined as origin in the history of Being, of ontology. The 'I' arises from the particular into the heights of a universal field of play as Being. Obsession destroys the centrality of the self to 'be' itself. It is a nether world which must always be awake, conscious, and find no rest. In obsession all things flee into a dead neutrality which cannot yet die but must be condemned merely to exist in the *il y a*, *isness*,

the sheer 'it is'. The *il y a* has no temporality. There is no interruption of the other. It is the self's freedom which the 'it' of 'is' has no beginning or end, finds nothing as everything, can only find termination in interminable nothingness, condemned to endlessly endure nothingness.

Levinas takes this as a hint of why the self cannot be what it pretends. Also, the 'inability to be able' as I have mentioned, the haze of birth and infancy, the passive endurance of old age, weakness, suffering and the finality of death from which the self has no power over render us helpless to be the eternal, immortal self. The historically fantasized resurrection of the self into Concept cannot include the sensual self, the self which desires to find immortality, to conquer death. Levinas tells us that the self is a fiction in self-fictionalizing fantasies which never dies upon the altar of its obsessions. Levinas tells us the only way to think of the self is as existential retreat from the radical alterity of the Other (Autrui). The diachrony of my time, my space, my incommensurability to create, sustain, immortalize me is not possible because I am not my own creator, and neither am I the 'not' of my own creator. Neither is the 'not' of my own creator some historical face of my equivalence with the history of Being which takes the name God. The self is the result of a passivity before all [my ideas] of passivity. The self is accused and persecuted because it owes debt it cannot repay. The self does not originate itself. The 'I' cannot congeal the ego into Being. The radical externality of the Other (Autrui) which I cannot assume in my freedom is not 'the not-of my origin of me'. 'The not-of my origin of me' in its assumed binary dualisms does not imply determinism wherein I had no choice, no say so, no freedom to become myself by myself. There is an absolute vulnerability that spawns me which cannot be deemed the 'No Exit' of Sartre or the great nausea of Nietzsche's eternal return of the same. In his or her face I do not 'find me', my 'self' as known-other, the negation of the same as the other in angst. Me, myself, 'I' finds itself situated from an other in which I have no

memory, no co-existed space or time. Ipseity, personal identity, individuality, selfhood, is not becoming, the self-inventing itself, from Being and nothingness. The NIH (National Institute of Health) tells us mental illnesses like schizophrenia all find deficiencies in these areas,

> The assessment of psychopathology in most contemporary research is based squarely on signs and symptoms of disorder, often measured in fairly crude checklist-type fashion. This approach has tended to indicate significant overlap in psychotic and other symptoms across disorders, eg, between schizophrenia and bipolar disorder1 and between psychotic disorders and borderline personality disorder. This may partly be the result of the assessment tools and conceptual frameworks being used. By contrast, insights from phenomenological psychiatry and philosophy, focused on disturbed subjectivity, indicate that disturbed self-experience or selfhood may underlie and generate many "surface-level" psychotic symptoms, particularly in schizophrenia spectrum disorders.
>
> There are many different meanings and controversies surrounding the notion of the "self." These controversies mainly concern its ontology or ultimate reality status, eg, as a kind of "substance," object, or process. The experiential, subjective notion of the self (the sense of self) is, however, widely acknowledged, both in the analytic philosophy of mind and in phenomenology. Two levels of the experiential self are typically proposed:
>
> 1. "Minimal" self, also referred to as "basic" or "core" self or as "ipseity." This is a pre-reflective, tacit level of selfhood. It refers to the implicit first-person quality of consciousness, ie, the implicit awareness that all experience articulates itself in first person perspective as "my" experience. In other words, all conscious acts are intrinsically self-conscious, a

feature sometimes designated as “self-affection.” “Minimal” or “core” self constitutes the foundational level of selfhood on which other levels of selfhood are built.

2. “Narrative” or social self. This refers to characteristics such as social identity, personality, habits, style, personal history, etc. Psychological concepts such as “self-esteem” or “self-image” refer to this level of selfhood. This level is widely understood to presuppose the sense of existing as a subject of experience (“minimal self”) and often involves reflective, metacognitive processes, in which one’s self is largely an object of awareness. [55]

In Levinas’ late and most well-known work entitled “Otherwise than Being or Beyond Essence” he asks us how can we be sure or *faithful enough to the anarchy of passivity* in the face of the Other (Autrui) and not just caught up unawares in yet another scheme of the history of Being (ontology)? What Levinas is asking is how do we ‘know’ if we are not weaving yet another tale of origin in which we play the role of the protagonist or the antagonist? Even ‘knowing’ itself can be active as “I know the answer” or passive as “The answer is known by me”. So, what does Levinas mean by “*faithful enough to the anarchy of passivity*”? Levinas writes near the end of the quote, “*Responsibility for another is not an accident that happens to a subject, but precedes essence in it, has not awaited freedom, in which a commitment to another would have been made.*” Levinas has a phrase which refers to this “*passivity more passive than all passivity*”. In other words, responsibility to the Other (Autrui) is not a doing or not-doing which I must choose or even not-choose. Rather, responsibility is a recognition of an excess which makes any such thing as a ‘me’ or a ‘not-me’ possible. the Other (Autrui) is a diachrony to me, a time not my time. Time is something that is always beyond the individual’s control and is constantly slipping away. In this sense, Levinas speaks of a “time not my time” to emphasize the idea that time is not something that can be owned or

possessed by the individual. The excess of other *branches* anarchically, not traceable to a self which originates time. The phrase "*passivity more passive than all passivity*" cannot be an active cause or passive effect coopted by a self which has the freedom to choose narratives. Levinas asks our question another way, "*How can all these senses of the facticity and irrevocable passing of time — the passive synthesis of time not entirely convertible into an active synthesis — be intelligibly subordinated to the time-structure of the relationship with alterity?*" (Levinas, Otherwise Than Being or Beyond Essence, 1981, p. 23) This will be a goal of the major section to be addressed. But for now, without being reductionary, in the context of this book's first major section on physics, perhaps we might be able to glimpse some kind of sense of Levinas' phrase "*passivity more passive than all passivity*" could be at least given an allegorical direction in the radical externality of the quantum wave function, its incomprehensible otherness from spacetime, histories, and classicisms. But let's not forget the spooky netherland of the wave function is not merely epistemological or ontological but yet, in its fall into classicism, gives us/me a sense of lived sensuality, feeling of embodiment in the world, which gets taken up as histories of the narrative as 'me here now'.

For now, I also want to note that in his work "Otherwise Than Being or Beyond Essence", Levinas makes a huge distinction with the 'saying' of the other where, for only an instant (dare we say the moment exformation branches into the classical 'me'), the radical alterity of the face of the Other (Autrui) breaks through only to be immediately forgotten, erased, lost, taken up into the form of consciousness as the 'said', the plasticity of 'me' as fallen into classicism. The 'said' is narrative, the history of Being or what I have referred to as the history, language, and culture which '*is*' what we passively take as practicality in common sense. This is the long quote I referred to at the beginning of this section,

In this exposition of the in itself of the persecuted

subjectivity, have we been faithful enough to the anarchy of passivity? In speaking of the recurrence of the ego to the self, have we been sufficiently free from the postulates of ontological thought, where the eternal presence to oneself subtends even its absences in the form of a quest, where eternal being, whose possibles are also powers, always takes up what it undergoes, and whatever be its submission, always arises anew as the principle of what happens to it? It is perhaps here, in this reference to a depth of anarchical passivity, that the thought that names creation differs from ontological thought. It is not here a question of justifying the theological context of ontological thought, for the word creation designates a signification older than the context woven about this name. In this context, this said, is already effaced the absolute diachrony of creation, refractory to assembling into a present and a representation. But in creation, what is called to being answers to a call that could not have reached it since, brought out of nothingness, it obeyed before hearing the order. Thus in the concept of creation ex nihilo, if it is not a pure nonsense, there is the concept of a passivity that does not revert into an assumption. The self as a creature is conceived in a passivity more passive still than the passivity of matter [could he mean the totality of all things which adhere to cause and effect?], that is, prior to the virtual coinciding of a term with itself. The oneself has to be conceived outside of all substantial coinciding of self with self. Contrary to Western thought which unites subjectivity and substantiality, here coinciding is not the norm that already commands all non-coinciding, in the quest it provokes. Then the recurrence to oneself cannot stop at oneself, but goes to the hither side of oneself; in the recurrence to oneself there is a going to the hither side of oneself. ‘A’ does not, as in identity, return to ‘A’, but retreats to the hither side of its point of departure. Is

not the signification of responsibility for another, which cannot be assumed by any freedom, stated in this trope? Far from being recognized in the freedom of consciousness, which loses itself and finds itself again, which, as a freedom, relaxes the order of being so as to reintegrate it in a free responsibility, the responsibility for the Other (Autrui), the responsibility in obsession, suggests an absolute passivity of a self that has never been able to diverge from itself, to then enter into its limits, and identify itself by recognizing itself in its past. Its recurrence is the contracting of an ego, going to the hither side of identity, gnawing away at this very identity — identity gnawing away at itself — in a remorse. Responsibility for another is not an accident that happens to a subject, but precedes essence in it, has not awaited freedom, in which a commitment to another would have been made. I have not done anything and I have always been under accusation — persecuted. The ipseity, in the passivity without arche characteristic of identity, is a hostage. The word I means 'here I am', answering for everything and for everyone. Responsibility for the others has not been a return to oneself, but an exasperated contracting, which the limits of identity cannot retain. Recurrence becomes identity in breaking up the limits of identity, breaking up the principle of being in me, the intolerable rest in itself characteristic of definition. The self is on the hither side of rest; it is the impossibility to come back from all things and concern oneself only with oneself. It is to hold on to oneself while gnawing away at oneself. Responsibility in obsession is a responsibility of the ego for what the ego has not wished, that is, for the others. This anarchy in the recurrence to oneself is beyond the normal play of action and passion in which the identity of a being is maintained, in which it is. It is on the hither side of the limits of identity. This passivity undergone in proximity by the force of an alterity in me is

> the passivity of a recurrence to oneself which is not the alienation of an identity betrayed. What can it be but a substitution of me for the others? It is, however not an alienation, because the other in the same is my substitution for the other through responsibility, for which, I am summoned as someone irreplaceable. I exist through the other and for the other, but without this being alienation: I am inspired. This inspiration is the psyche. The psyche can signify this alterity in the same without alienation in the form of incarnation, as being-in-one's-skin, having-the-other-in-one's-skin. 56

For quantum physics, even as a universe or universes emerge from entanglement, how could the self, myself, rise from what is not my own? Could radical externality arise in the face of the Other (Autrui) which throws us back *as* self, *as* myself? Surely, this could not 'be' but as we have seen 'to be' is implicated in narrative, a narrative of history which has become common sense and practicality. We can no longer afford to be enticed, entranced, by a fiction, an abstraction, which looms as Being, as presence and its *logos* that has congealed and completed itself in absence, in logic. From the previous discussions in this book, I hope we know that origin becomes infinite regression that is perpetually condemned to lose itself and re-find itself in the tireless play of cause and effect. We never discover 'origin'. We always only defer it (transactionally?) to yet another replication of rationality. This infinite regression is not from the 'way that it is'. What our history has reductively guaranteed is that the radical externality of the other must go underground, it must be effaced as the absolute 'not' of totality. Becoming must overtake the other as Concept or perhaps as lived practicality which solidifies and covers over externality. It cannot stand the scrutiny of contingent Being and can only persist as universal Concept. Levinas contests the overcoming of Being into Concept with the idea of anarchy. However, this comes with a

major caveat.

Anarchy linguistically comes forward from history as the negation of *archy* (ἀρχή, origin). The prefix *an* negates *archy*. This is a simple and logical reduction to origin and the 'not' of origin which has no exteriority. As we have found with exformation, there is a hazy middle with *logos,* which cannot be summed up and concluded by logic. Thus, even origin as the history for *phusis* for later Greeks like Aristotle and Plato came with a hazy, chaotic backdrop from their own ancestors. This backdrop has long been lost to modernity. I can almost hear Kierkegaard sarcastically protest that the (Hegelian) System in the "Science of Logic" is not quite complete. However, in the current day the Logic has become completed merely in the feigned *logic* of politics, practicality, and common sense. Ironically, instead of science positively and finally finishing the System, it appears to be collapsing into an *ad hoc* finality which could damn well extinguish us, Homo sapiens.

The abyss we face makes no promises for species survival, planetary survival. The reactionary promise of logic completed has run its course through time. The genealogy of cause and effect beginning in origin, whether it be the gods, God, or empirical objectivity has exhausted itself in the face of its own science of quantum *phusis*. Quantum *phusis* undermining the futile promises of the logic of cause and effect, spacetime, the mythic completion of the System has arrived at a gaping abyss. The indeterminate, spooky haze of the observer effect which cannot mechanically shed itself of Victor Frankenstein. Being taken up into an eschatology of Concept has exhausted itself in the Logical *telos* of absolute certainty. Only the repetition of authoritarian force and violence dialectically guarantees extinction. But ancient and vague intuitions of *phusis* as chaos which cannot be taken up into binary dualities of classicism leave us before a yawning gap which cannot be summed up cleanly by promises of being and not-being, absolute Concept which must forget itself to *be* absolute, order and disorder, origin and anarchy where anarchy is the 'not' of origin. *Phusis* in its

ancient hazy intuitions gave way to strife to usher in classicism's logic and totalities. However, at the end of the epoch of strife the void we face is the between and exterior to Being and Nothing (as the 'not' of Being and *vice versa*). From the yawning gap of *phusis* and the exhaustion of strife quantum physics brings exteriority before us. Chaos is excess and branching into classicism's logic as subjective and objective where subjective resists the force of modernist objectification in reactionary fanaticisms and extremisms. The logic of dialectical oppositions of order and disorder, origin and the 'not' of origin must always concede to lifting itself up into higher and higher unities until Concept remains absolute even when and because it must forget itself. Any excess must finally and teleologically be vindicated in the absolute. Exceeding itself must be absolute in which even the 'not' of absolute must recursively define Identity - one without another. Even excess must be discounted by the history of metaphysics which must bow before immanentism. However, the path of metaphysics' failure and quantum physics leads us in an 'other' direction. All the 'nots' of binary dualisms cannot be brought under domination and force by their thesis. However, the 'nots' of binary dualisms need not be subjugated to their masters. They are not allowed to exceed their masters as an unrecoverable excess, they cannot be lost in the nether lands and underworlds of anarchy but must persist in sheer obsession in which even extinction becomes yet another obsession. Quantum physics gives way and allows classism's narratives but as a limited case of the observer. An exteriority to the 'not' of anarchy, of origin, a "*passivity more passive than all passivity*" behind the violence of origin and Narcissus' echo.

Levinas speaks of anarchy as not simply origin and no-origin but as what origin and no-origin cannot conceive. This is what Levinas calls the hither side of identity, the tautological 'I' which totalizes itself in the identical universalism of logic. Despite the pretense, the System and the 'I', can never be completed or finalized. The pretense for Being to rise into Concept cannot take absolute account

but only exhausts itself in its violent attempts. Sure, it can play in the polarities of logic and its histories but similarly to classical physics, it can never take full account. It can only be a limiting case with historic assumptions that abstract us away from any such thing as exformation. Levinas died on December 25, 1995. I am sure he knew something about quantum physics, but I know of nowhere that he writes about it. However, the failure of history and Being to finally take full account in Concept and its frenetic progeny is because the Other (Autrui) is not Concept. The Other (Autrui) is not taken up into Concept. Anarchy is oblique in Levinas. In terms of this book, I have used Levinas' sense of anarchy in the term 'chaos'. Anarchy cannot rest in negation of origin. It always has a residue which origin and not-origin cannot totalize. Science is at the least the historic surety of Western truth which aspires to finalizing logic as identity from the completion of a theory of everything which has no excess to be discovered, which lays all truth bare to facts at least in theory but only exists as obsession in *reality*. Now theory in science, truth in science, has led science back towards a beginning in philosophy which once again faces an unaccounted-for excess.

The conventional wisdom in physics is for a positivism that will meld perfectly with empiricism. This would be the scientific *telos* (final completion or goal) of Hegel's Concept. This direction conserves the philosophical underpinnings of science whose 'legitimacy' is preserved by guarding against religion and metaphysics. Simultaneously, the virtue of science is its perseverance on observation of the other, the physicality of what shows itself in phenomena. It has historically resisted losing the otherness of *phusis* at any cost…the disproving of antiquated theories, the strewn and discredited careers of scientists throughout history. In keeping with Thomas Kuhn's "The Structure of Scientific Revolutions" science has a messy process of adopting new paradigms which involve a lot more than just the naive beliefs of truer truths (e.g., capital acquisition, political pressures, stable career pathways led by consensus, etc.). In spite of this messy

process, it has to a notable degree kept its end goal on phenomenon, the other, which does not collapse in on merely establishing self-serving power interests. Capitalism, religion, and philosophy have historically demonstrated a susceptibility to vested interest, interests which by any means will usurp themselves over and against the other. To the degree that science has not relinquished its focus on the other as phenomena is why it now faces a ghostly phantasm which philosophically undergirds much of its history - rationalism. With the advent of quantum physics, we find an emergent spooky alliance in science with its other half, philosophy. This inevitable reunion feels like a chasm, a chaos, a yawning gap. This is the *phusis*, the abyss, which stared back into early Greek civilization that we lost along the way. I don't want to be presumptuous because I have not studied other civilizations enough, but I suspect that this chasm has, in one way or another, haunted all early civilizations. Similarly, Levinas writes of an anarchy which cannot be subsumed as the 'not' of *archy*, of origin. Levinas writes of a "*passivity more passive than all passivity*". All of this is excess to the absoluteness of identity in logic, the perpetual deferment of origin in its negation, the tautology of presence and absence, the *not* of presence. But absence leaves a leftover residue which comes in the morning, yet again, with the she or he we face.

HISTORIES OF ORIGIN

I know this beginning has been difficult, more like a sensual plunge than a contextual approach which moves more slowly. To do this more contextually, I need to back up and start anew. However, I hope this beginning can give the reader a sense of where this is going and make the journey more amenable (if that is possible with my limited abilities). The next section will philosophically explore the path which has led us here with an emphasis on the 20th century. This will be a bit of a nerdier philosophical step back into histories of origin. However, I will throw out some ideas which will

tie back into quantum physics as simply possible stepping-off points for speculation. I will not adhere strictly to temporal ordering of these topics as the way they filter down to our everyday lives and commonsense have little relevance to that kind temporal ordering. This will eventually wind its way back towards implications for us, for me, and the 'I' with proximity to the Other (Autrui), the he or she which faces us. What was the hope born of Enlightenment and modernity and borne by classicism? How did these histories as well-trod world-scape lead us to the abyss?

On Nature as Love and Strife

Earlier in the section entitled, "The Failure of Intuition and Phusis" I brought up Empedocles. I want to go into more detail and bring a quote up I mentioned before. But first, here is a bit of background on Greek mythology.

- Zeus, the chief deity of the ancient Greek pantheon, reigns as the ruler of the gods from his celestial abode atop Mount Olympus. His influence extends over the sky, weather, and natural forces. Zeus holds the title of father to both divine beings and mortal humans. His role as a protector and ruler encompasses all realms of existence. According to Greek poet Homer, Zeus's heavenly domain is the summit of Mount Olympus, the highest peak in Greece. There, he governs the affairs of gods and mortals, rewarding virtue and punishing wrongdoing. Zeus is often depicted as an older man with a beard, and his symbols include the lightning bolt and the eagle. In a Cretan myth, Zeus's mother, Rhea, saved him from being swallowed by his father, Cronus, who feared one of his children would dethrone him. Rhea replaced Zeus with a stone and hid him in a cave on Crete. After growing to manhood, Zeus led a revolt against the Titans and

dethroned Cronus, sharing dominion over the world with his brothers, Hades and Poseidon. Zeus's influence extends beyond the celestial; he is also the protector of cities, homes, property, strangers, guests, and supplicants. His complex character combines authority, justice, and a touch of divine mischief. Sky and Thunder God: Zeus is the embodiment of the sky and weather. He wields thunderbolts, sends lightning, rain, and winds. His traditional weapon is the mighty thunderbolt. [57]

- Hera, known as Hēra (Ἥρα) in Greek, holds a prominent place in ancient Greek mythology. She embodies several significant roles. Hera is the queen of the gods and the patroness of marriage. She oversees the sacred union between spouses and the bonds of matrimony. Her role extends beyond mere partnership; she symbolizes the harmony and commitment within marriage. As the goddess of women, Hera safeguards their interests and well-being. She watches over women during childbirth, offering protection and guidance during this crucial phase of life. Hera's influence extends to family life. She is associated with motherhood, fertility, and the welfare of children. Her maternal aspect emphasizes her nurturing and protective qualities. Hera is one of the twelve Olympian deities who reside on Mount Olympus. She holds a position of authority and power among the divine assembly. Her regal demeanor reflects her status as the queen of this celestial pantheon. While Hera embodies nobility and authority, she is also known for her jealousy and vengeful nature. Her husband, Zeus, often tested her patience with his numerous affairs. Hera ensured that each of Zeus's consorts faced challenges and trials. Hera is depicted as both a majestic figure and a complex goddess with human emotions. Her stories intertwine with those of other gods and heroes, making her an integral part of

Greek mythology. [58]

- Aidoneus, also known as Hades, is a significant figure in ancient Greek mythology. Aidoneus was a mythical king of the Molossians in Epirus. He is often depicted as the husband of Persephone. The story involving Aidoneus is closely tied to the abduction of Persephone. After Theseus and Pirithous concealed Helen at Aphidnae, they sought to reward Pirithous by obtaining Kore (another name for Persephone) as his wife. When Aidoneus discovered their intention to take his wife, he had Pirithous killed by Cerberus, the three-headed dog guarding the entrance to the underworld. Aidoneus then captured Theseus, who was later released upon the request of Heracles. The legend of Aidoneus essentially mirrors the myth of Hades kidnapping Persephone, with the mythical king serving as a substitute for the god Hades himself. The name "Aidoneus" is a lengthened form of the Greek word for Hades (Ἅιδης), which infrequently appears in original sources, including Homer's works. As the ruler of the subterranean realm inhabited by the shades of the dead, Aidoneus plays a crucial role in the Greek pantheon. [59]
- Nêstis was the daughter of Zeus and Demeter. Her uncle Hades abducted her, and she became queen of the underworld and goddess of death. Hades would later marry her. Every spring she could return to the surface which resulted in the return of spring. Nêstis is found in much earlier myths pre-Greek all over the world with different names going all the way back to Proto-Indo-European. Nêstis, in ancient Greek mythology, is associated with water. She represents various forms of water, including mist, rain, moisture, and steam. However, her most significant role is as the queen of the underworld. Due to the reverence and caution surrounding her name, she is often referred to by other

euphemistic titles such as Cora or Kore. Interestingly, Nêstis is also linked to moistening mortal springs with tears, as mentioned in a text attributed to the philosopher Empedocles. Her dual nature as both a water goddess and a ruler of the underworld adds depth to her character in Greek mythology.

Empedocles (born early fifth century BC) [60] a student of Parmenides of Elea [61] in the late sixth century of early fifth century BC wrote a work referred to as "*On Nature"* where he states,

Hear first of all the four roots of all things:
Zeus the gleaming, Hera who gives life, Aidoneus,
And Nêstis, who moistens with her tears the mortal fountain.[62]

The 'roots' are the four deities Zeus, Hera, Aidoneus, and Nêstis (Persephone). Zeus is the son of Cronus. Chronus is related to Cronus. In Greek mythology, Cronus (also spelled Kronos) was the Titan god of time and the leader of the Titans. He was known for devouring his own children, fearing that they would overthrow him. However, his son Zeus managed to escape and eventually defeated Cronus, becoming the ruler of the gods. Chronus (sometimes spelled Khronos) is a concept in Greek mythology representing time itself. Unlike Cronus, who was a specific deity, Chronus embodies the abstract notion of the passage of time. In art and literature, Chronus is often depicted as an old man with a flowing white beard, symbolizing the inexorable march of time like Zeus. So, while Cronus is a specific character from mythology, Chronus represents the broader concept of time, which transcends individual gods and mortals. Zeus has to defeat father time in order to be. Hera is the goddess of union, she watches over women and childbirth, offspring, fertility, maternal and nurturing, and growth. She is the guardian of well-being. She also knows her husband Zeus

can be a pain in the ass, obstinate, overly assertive, thinking too highly of himself, yet still understanding of his trials and tribulations. Aidoneus as the king of Hades, death, who abducts his niece Nêstis and forcibly betroths her but even though she is horribly abused she is still the origin of spring and even empathizes with her abuser not because of him and who he is but because of her and who she is. She cannot be subsumed under even the threat of hell. She cannot lose herself. But she cannot be named. Interestingly,

> Of the four deities of Empedocles' elements, it is the name of Persephone alone that is taboo – Nêstis is a euphemistic cult title[e] – for she was also the terrible Queen of the Dead, whose name was not safe to speak aloud, who was euphemistically named simply as Kore or "the Maiden", a vestige of her archaic role as the deity ruling the underworld. Nestis means "the Fasting One" in ancient Greek. 63

In my opinion our present-day cult of history still cannot speak ***her*** name which should make all of us weep. Even in the dry thirst of eternal Hell she "*moistens with her tears the mortal fountain*". If this does not bring to the fore passion, love and strife, all wrapped in the garb of existence, the necessity of Hades awaits us until perhaps eternal echoes usher in yet another spring which may yet become.

In fragment 17 of Diels-Kranz' sixth edition entitled "*Die Fragmente der Vorsokratiker*" (The Fragments of the Pre-Socratics), apparently speaking of the physical world as a whole, Empedocles states his fundamental thesis about the relation of roots: 64

> Twofold is what I shall say: for at one time they [i.e., the elements] grew to be only one
>
> Out of many, at another time again they separate to be many out of one.

And double is the birth of mortal things, double their death.

For the one [i.e., birth] is both born and destroyed by the coming together of all things,

While the other inversely, when they are separated, is nourished and flies apart (?).

And these [scil. the elements] incessantly exchange their places continually,

Sometimes by Love all coming together into one,

Sometimes again each one carried off by the hatred of Strife.

<Thus insofar as they have learned to grow as one out of many,>

And inversely, the one separating again, they end up being many,

To that extent they become, and they do not have a steadfast lifetime;

But insofar as they incessantly exchange their places continually,

To that extent they always are, immobile in a circle.[65]

Much of this is thought to have come from Empedocles teacher Parmenides. I will discuss the ancient idea of time in this passage soon but for now time is not how we think of time for the ancient mind. Time was more like what we think of as a quality. Therefore, in the first sentence of the quote above think of time as a quality, as growth, as 'grew to be one'. Even as early as the late sixth century BC, Parmenides and his student Empedocles are speculating on growth and its unique capacity to be 'many' and 'one'. This odd observation of phenomenon causes 'doubling'. Doubling might be referred to as binary dualisms much later in history. Life and death have doubles. For each is 'born' and 'destroyed' at the same *time,* or more precisely as the *telos* of growth. 'Coming together' and 'falling apart' have a simultaneity. They both 'depend on each other' and

‘exchange places continually’. Love is ‘coming together’. Strife is ‘falling apart’. ‘Becoming’ does not have a ‘steadfast lifetime’. Becoming interchanges ‘continually like a circle’.

All of this is based on the claim that everything is composed of four roots which are moved by two opposing forces, Love and Strife. Since the roots are identified by the names of deities (Zeus, Hera, Aidoneus, Nêstis) —and not by the traditional names for the elements fire, earth, air, and water—there are rival interpretations of which deity is to be identified with which root. Nevertheless, there is general agreement that the passage refers to fire, earth, air (= aether, the upper, atmospheric air, rather than the air that we breathe here on earth) and water (cf. B 109 = D 207). Aristotle credits Empedocles with being the first to distinguish clearly these four elements (*Metaphysics*. 985a31–3). However, the fact that the roots have divinities’ names indicates that each has an active nature and is not just inert matter (Rowett 2016). These roots and forces are eternal and equally balanced, although the influence of Love and of Strife waxes and wanes.[66]

Immediately one is struck by the comprehensive symmetry of this scheme. It seems to address coming-to-be and passing-away, birth and death, and it does so with an elegant balance. The four roots come together and blend, under the agency of Love, and they are driven apart by Strife. Empedocles also describes a time when Strife had separated the roots. This separation is total and is the opposite pole from the *circle*, which is a total mixture under the influence of Love.

> When Strife has reached the deepest depth
>
> Of the vortex, and Love has come to be in the center of the whirl,
>
> Under her dominion all these [i.e., the elements] come together to be only one,
>
> Each one coming from a different place, not brusquely, but willingly [67]

First of all, this somewhat mysterious description suggests that the means by which Strife separates the roots from the beginning is a vortex. Heavier elements like earth settle in the middle and lighter ones like fire are pushed to the periphery. This reference to the vortex also implies that dominance by Strife is characterized by the whirling motion of the cosmos as we know it. In addition, this fragment suggests the end of the rule of Strife and the beginning of the rule of Love, as this principle begins to insinuate itself into the elements. The latter part of this passage describes the unifying effect of Love.[68] Additionally, somehow strife and love seem to still have relevance for daily life.

These very ancient intuitions have their own meanings to those that lived them which makes it difficult if not impossible at times to decipher. However, I want to make some way out of bounds comments which I have no doubt some would be abhorred by. Could there be a kind of allegorical intuition in all this with the quantum wave function? Perhaps, we could venture some creative speculation that there is a type of doubling which cannot be reduced or resolved into one or the other and yet have some odd characteristics,

- the ‘elements’ as ‘one’ or ‘many’ as the quality of ‘growth’ perhaps reminiscent of the wave function and its many branchings where ‘growth/becoming’ is the observer effect falling into classicisms (e.g., spacetime/quanta)
- the branchings of the observer effect have a kind of ‘doubling’ in simultaneity with the wave function and narratives of classicisms
- these doublings form doubling dualisms of ‘birth/death’, ‘come together/falling apart’, ‘love/strife’, steadfast as lifetimes and histories/exchanging places continuously as overlapping/simultaneous many-worlds of possibilities, being as mobile in becoming/immobile as a circle which ever goes around but stays the same - all symbiotic on

each other

- all of these doublings bring to the fore love and strife, the many as the one/the one as the many, the coming together and falling apart but somehow all bringing us to the possibility of growth, of a sense of radical exteriority which has something to do with responsibility and not whether we respond but how we respond.
- can we think - rhizomes and the tree of life?

Ok, a stretch to say the least but the oddness of how Empedocles phrases this reminds me (at least) of the oddness of the quantum wave function which cannot find easy categories and patterns of thinking. And the later quote where strife has reached the deepest depth – can we think the violent vortex as Big Bang singularity, wormhole, where exformation is chaos and love, branching, the part of spacetime we inhabit which gets centered in life and love from the spooky observer effect and the one and many which calls itself 'me'. Empedocles calls this the domain of "her", Nêstis which finds no name, the stranger, the sojourner, where each one becomes in a 'different place' not from rudeness, bluntness, or curtness but tactfully and willingly.

Obviously, I am not implying the Empedocles had the quantum wave function in mind here! But what I am doing is showing how to speculate, to start to engage actively in making connections no matter who thinks it is right or wrong, true or false, etc. This is how we start to engage in growth, learning, becoming one with a process which is a journey and not a destination. There are woefully too many folks out there that find joy in raining on parades. But instead of resorting to a kind of defensive gamesmanship with them why not learn the practice of looking for the value in what the other brings to us regardless of what we imagine their motivations may be? What matters is whether to die in transactional gamesmanship or live in an open quest for an alterity of the other which finds no contentment in hearing one's own echo. Let's see if we can hear

another voice to our echo of time in an ancient and other temporality.

Time in Aristotle's aion

We all have an idea of time as eternal. However, time as eternal has its roots in Latin Christianity, the monotheistic God who was one and never changed. The Greek word *aion* was translated to mean 'eternity' in Latin. In Heleen M. Keizer's paper "'ETERNITY' REVISITED: A Study of the Greek Word *aion*" she states,

> The history of aiôn starts with aiôn being a word for 'life'; indeed, in Homer aiôn is far from being a word for 'time' but rather has the connotation of 'force of life'. A word with which aiôn in Homer is combined, is psuchê. The Greek language has yet two other words to designate life: there is zôê, indicating the state of being alive (not yet in Homer), and bios, indicating the ways and means
>
> of maintaining that state. Thus while zôê refers to the life 'bred' and bios to the life 'led', aiôn can well be characterized as designating the life 'had'. My investigation of aiôn in Greek literature from Homer to Hellenism has shown me a coherent complex of meaning of the word, which turned out to be built up from the following three notions: 'life', 'time', and what I call 'completeness', 'wholeness', or 'entirety'. Aiôn refers to 'life' as a 'whole' of 'time' — hence, besides 'lifetime' it can also designate life's 'lot'…
>
> Gathering my conclusions about the role allotted to aiôn successively in the philosophy of Empedocles, Plato, Aristotle, the Stoa and Epicurus, I observe that this role is a cosmological one. In Empedocles (fragment B16 Diels-Kranz) we seem to meet aiôn for the first time on a cosmic scale as the 'life' of the cosmos, coinciding with the whole of time. For Plato (discussed in more detail in §2a), aiôn — usually

translated ‘eternity’ — is the unitary whole of ‘life(time)’ on the intelligible level, which chronos (time) displays or ‘counts out’ on the sensible level. In Plato for the first time we find aiônios as the adjective form of aiôn (‘aiônic’). Aristotle (more about him in §2b) defines aiôn as that which encompasses the infinite time of the cosmos, in analogy of aiôn as

that which encompasses the time of an individual person’s life; the particular term Aristotle uses here is telos (‘the telos encompassing the time…’). In Plato’s system, aiôn is reserved for the intelligible, transcendent world; in Aristotle, aiôn (called divine, and as telos touching upon the first, transcendent, principle) is the comprising sum of the immanent, sensible world of time itself…

Aristotle’s first definition of aiôn, “the telos which encompasses the time of everyone’s life”, fits in perfectly with what I have indicated above as characterizing aiôn in earlier writers (‘the ancients’), viz. that the word refers to a person’s life as a complete(d) whole with the inherent aspect of time. Aristotle subsequently points out that aiôn, thus defined, applies to the entire cosmos as well — in doing so he implicitly follows Plato…

In the first book of De caelo, chapter 9, Aristotle offers an almost lexicographic description of what the word aiôn in his view conveys. De caelo, in Greek Peri ouranou, is a work on physics, dealing with cosmology: Aristotle uses the word ouranos (Lat. caelum) not only to designate the heavens but also the cosmos, or universe. The universe, Aristotle argues in I 9, is made of the totality of matter, and so ‘outside the universe’ there is neither matter nor what is associated with matter, viz. space and time. When Aristotle subsequently talks about the things or beings ‘over there’, De caelo as a work on physics touches upon the divine: it appears to refer to the prime, unmoved Mover, also elaborated as a plurality

of unmoved Movers, which is the divine transcendent principle discussed by Aristotle in book XII, chapters 6-8, of his Metaphysics. I now quote De caelo I 9

279a18-30:

Therefore, those-over-there are not such as to be in place, nor does time cause

them to age, nor does change work in any way upon any of those that are

arrayed beyond the outermost motion: unalterable and impassive, in having the

best and most self-sufficient life (zôê) they continue (throughout) the whole

aiôn.

a22 Indeed, that name [sc. aiôn] has been divinely uttered by the ancients.

For the completion (telos) which encompasses the time of everyone's life

(zôê), which cannot in nature be exceeded, has been named everyone's aiôn.

Along the same line of thought also the completion of the whole universe,

the completion which encompasses time as a whole and infinity, is aiôn,

having taken the name from aei einai [to be always], being immortal and

divine.

From there depends for all other things, for some more directly, for others more obscurely, being and life (zên)… At the start of the second book of De caelo, Aristotle summarizes what he has

demonstrated in the first book. I quote De caelo II 1 283b26-30:

the universe as a whole neither has come into being nor admits of destruction,

as some assert that it does, but is one and everlasting (aïdios) with no beginning

or end (teleutê) of the (/its) whole aiôn, but containing and encompassing in

itself the infinite time (chronos). 69

For Aristotle the idea of 'eternity' was not endless time as we might imagine it now. Eternity as *aiôn* expressed a quality first not a temporality. The quality expressed was teleological. The Greek notion of *telos* was thought as the ultimate completion or fulfillment of something whether it was the building of a house which found its *telos* in the end result - the actual house, or the result of a life well lived. This also gives us a hint of how temporality showed itself to the ancient Greek mind. We tend to think anachronistically meaning we think everyone at all times experienced times in the linguistic ways that we do. The ancient Greeks had no way to think about 'eternity' the way we do. They had no classical science to draw from. They thought in terms of qualities in which ages or epochs were *telos*. For our purpose, *telos* means the end of some action was the quality of completion and fulfillment of that action. Even more *telos* was used with an individual meaning as not just the quality of one's lifetime but also as a quality of goal or completion for a civilization. I find this to be evident as well in another Greek notion of time as *Kairos.* Permeating ancient Greece from the earliest to the latter citizens and thinkers and very important to Aristotle, was the notion of *kairos* meaning 'the opportune moment'.70 This was the moment of passion and fulfillment. It was purely qualitative. It was more like what we think of as a profound moment when something momentous happens. For Aristotle, the uncaused, the "immovable", was the *telos* of cause and effect, motion, which was uncaused and motionless. It was responsible for the cosmos. Therefore, it was the 'good', the fulfillment of its end. It was also the 'good' for something because all existence was the result of the immovable.

Also, oddly enough, let's highlight this remark from Aristotle's discussion a little further down, "*it [the good] causes motion as being an object of love*". Plato had another odd notion which is intriguing and has spawned much scholarly debate which translated means, 'the good beyond being'. Aristotle states, "For the final cause is not only the good for something," but also "the good which is the end of some action." In the latter sense it applies to immovable things, although in the former it does not; and it causes motion as being an "object of love", whereas all other things cause motion because they are themselves in motion. Aristotle tells us that everything that moves must have a cause. Therefore, there must be a final cause that will have several characteristics:

1. The "final cause" or origin must be the good as it is "good for something", i.e., the cosmos.
2. The 'good' generates motion or, for our purposes, time and space, cause and effect.
3. The 'good' cannot have a cause. It is the unmoved mover.

What is the unmoved mover? As already discussed, the unmoved mover was not in time or space and not the cause of anything else.

Origin and the Good Beyond Being

Plato tells us something strange in the Republic with the phrase ''*epekeina tês ousias*'' or 'the good beyond being'. Ever since Plato uttered this phrase scholars have discussed it many times over the centuries especially in the 20th century. What did Plato have to say concerning this seemingly odd idea?

Plato, a mentor of Aristotle, echoes his notion of the good in the Republic (Book 6, Section 509a through Book 7,518e). This is Plato's allegory of the cave. Socrates is having a dialogue with both of his brothers Adiemantus and Glaucon. The dialog happens in the home of an old man named Cephalus. The setting in Athens looks

very grim for Socrates as the Athenians had just been defeated in the Peloponnesian War in 404 BC. A pro-Spartan oligarchy called the Thirty Tyrants is about to tragically take over Athens. The "Great Beast" is the society which is about to take over Athens. The "Great Beast" is the society which is about to take over Athens. Socrates wants to show how the Athenians can gain freedom over the Beast.

More generally, the allegory is about Plato's notion of the Forms (Greek *Eidos*, Ideas). The Forms are the realities behind what shows itself to us in phenomena. The Forms cannot be directly perceived. This dialog does not exemplify the later metaphysical and classical notions of a comprehensible origin. Rather, it emphasizes what the ancient Greek philosophers called *steresis* or privation. All humanity lives in a cave where shadows of the Forms are cast onto the walls. Outside the cave are the Forms. However, humanity is condemned to only seeing the shadows. This is privation or incapacity to see what is truly real. Plato was fully aware of an older backdrop to his Forms and privation in the ancient Ionians. *Peiron* in '*apeiron*' is the Ionic Greek for boundary or limit. For Plato, humanity lives in privation as boundary or limit, the cave. The older form of boundary or limit, *peras*, also meant 'beyond' or 'further'. Thus, *apeiron* in Ionic Greek from Anaximander is the alpha privative, the privation of boundary and limit or without boundary or limit. Plato was also aware of the Greek history of origin and chaos from Hesiod, Anaximander, and Heraclitus. Plato, in the chaotic darkness of Athens to come, looks into *apeiron* and glimpses the Forms. I am going to include much of the dialog below because I think it is worth reading instead of summarizing. I will highlight some of Plato's remarks which demonstrate privation.[71]

Plato's *Republic*

it is right to deem light and vision sunlike, but never to think that they are the sun, so here it is right to consider

these two their counterparts, as being like the good or boniform, but to think that either of them is the good is not right. Still higher honor belongs to the possession and habit of the good."

Glaucon,

"An inconceivable beauty you speak of," he said, "if it is the source of knowledge and truth, and yet itself surpasses them in beauty. For you surely cannot mean that it is pleasure."

Socrates,

"Hush," said I, "but examine "In like manner, then, you are to say that the objects of knowledge not only receive from the presence of the good their being known, but their very existence and essence is derived to them from it, though **the good itself is not essence** but still transcends essence in dignity and surpassing power."

Glaucon,

And Glaucon very ludicrously said, "Heaven save us, hyperbole can no further go."

Socrates,

"The fault is yours," I said, "for compelling me to utter my thoughts about it."

Glaucon,

"And don't desist," he said, "but at least expound the similitude of the sun, if there is anything that you are omitting."

Socrates,

"Why, certainly," I said, "I am omitting a great deal."

Glaucon,

"Well, don't omit the least bit," he said.

Socrates,

"I fancy," I said, "that I shall have to pass over much, but nevertheless so far as it is at present practicable I shall not willingly leave anything out."

Glaucon,

“Do not,” he said.

Socrates,

“Conceive then,” said I, “as we were saying, that there are these two entities, and that one of them is sovereign over the intelligible order and region and the other over the world of the eye-ball, not to say the sky-ball, but let that pass. You surely apprehend the two types, the visible and the intelligible.”

Glaucon,

“I do.”

Socrates,

“Represent them then, as it were, by a line divided into two unequal sections and cut each section again in the same ratio (the section, that is, of the visible and that of the intelligible order), and then as an expression of the ratio of their comparative clearness and obscurity you will have, as one of the sections of the visible world, images. By images I mean, first, shadows, and then reflections in water and on surfaces of dense, smooth and bright texture, and everything of that kind, if you apprehend.”

Glaucon,

“I do.”

Socrates,

“As the second section assume that of which this is a likeness or an image, that is, the animals about us and all plants and the whole class of objects made by man.”

Glaucon,

“I so assume it,” he said.

Socrates,

“Would you be willing to say,” said I, “that the division in respect of reality and truth or the opposite is expressed by the proportion: as is the opinionable to the `knowable so is the likeness to that of which it is a likeness?”

Glaucon,

“I certainly would.”

Socrates,

“Consider then again the way in which we are to make the division of the intelligible section.”

Glaucon,

“In what way?”

Socrates,

“By the distinction that there is one section of it which the soul is compelled to investigate by treating as images the things imitated in the former division, and by means of assumptions from which it proceeds not up to a first principle but down to a conclusion, while there is another section in which it advances from its assumption to a beginning or principle that transcends assumption, and in which it makes no use of the images employed by the other section, relying on ideas only and progressing systematically through ideas.”

Glaucon,

“I don't fully understand what you mean by this,” he said.

Socrates,

“Well, I will try again,” said I,” for you will better understand after this preamble. For I think you are aware that students of geometry and reckoning and such subjects first postulate the odd and the even and the various figures and three kinds of angles and other things akin to these in each branch of science, regard them as known, and, treating them as absolute assumptions, do not deign to render any further account of them to themselves or others, taking it for granted that they are obvious to everybody. They take their start from these, and pursuing the inquiry from this point on consistently, conclude with that for the investigation of which they set out.”

Glaucon,

“Certainly,” he said, “I know that.”

Socrates,

“And do you not also know that they further make use of the visible forms and talk about them, though they are not thinking of them but of those things of which they are a likeness, pursuing their inquiry for the sake of the square as such and the diagonal as such, and not for the sake of the image of it which they draw? And so in all cases. The very things which they mould and draw, which have shadows and images of themselves in water, these things they treat in their turn as only images, but what they really seek is to get sight of those realities which can be seen only by the mind.”

Glaucon,

“True,” he said.

Socrates,

This then is the class that I described as intelligible, it is true, but with the reservation first that the soul is compelled to employ assumptions in the investigation of it, not proceeding to a first principle because of its inability to extricate itself from and rise above its assumptions, and second, that it uses as images or likenesses the very objects that are themselves copied and adumbrated by the class below them, and that in comparison with these latter are esteemed as clear and held in honor.”

Glaucon,

“I understand,” said he, “that you are speaking of what falls under geometry and the kindred arts.”

Socrates,

“Understand then,” said I, “that by the other section of the intelligible I mean that which the reason itself lays hold of by the power of dialectics, treating its assumptions not as absolute beginnings but literally as hypotheses, underpinnings, footings, and springboards so to speak, to enable it to rise to that which requires no assumption and is

the starting-point of all, and after attaining to that again taking hold of the first dependencies from it, so to proceed downward to the conclusion, making no use whatever of any object of sense but only of pure ideas moving on through ideas to ideas and ending with ideas."

Glaucon,

"I understand," he said; "not fully, for it is no slight task that you appear to have in mind, but I do understand that you mean to distinguish the aspect of reality and the intelligible, which is contemplated by the power of dialectic, as something truer and more exact than the object of the so-called arts and sciences whose assumptions are arbitrary starting-points. **And though it is true that those who contemplate them are compelled to use their understanding and not their senses, yet because they do not go back to the beginning [arche] in the study of them but start from assumptions you do not think they possess true intelligence about them although the things themselves are intelligibles when apprehended in conjunction with a first principle.** And I think you call the mental habit of geometers and their like mind or understanding and not reason because you regard understanding as something intermediate between opinion and reason."

Socrates,

"Your interpretation is quite sufficient," I said; "and now, answering to these four sections, assume these four affections occurring in the soul: intellection or reason for the highest understanding for the second; assign belief to the third, and to the last picture-thinking or conjecture, and arrange them in a proportion, considering that they participate in clearness and precision in the same degree as their objects partake of truth and reality."

Glaucon,

“I understand,” he said; “I concur and arrange them as you bid.

Socrates,

Next,” said I, “compare our nature in respect of education and its lack to such an experience as this. **Picture men dwelling in a sort of subterranean cavern with a long entrance open to the light on its entire width. Conceive them as having their legs and necks fettered from childhood, so that they remain in the same spot, able to look forward only, and prevented by the fetters from turning their heads. Picture further the light from a fire burning higher up and at a distance behind them, and between the fire and the prisoners and above them a road along which a low wall has been built, as the exhibitors of puppet-shows have partitions before the men themselves, above which they show the puppets**.”

Glaucon,

“All that I see,” he said.

Socrates,

“See also, then, men carrying past the wall implements of all kinds that rise above the wall, and human images and shapes of animals as well, wrought in stone and wood and every material, some of these bearers presumably speaking and others silent.”

Glaucon,

“A strange image you speak of,” he said, “and strange prisoners.”

Socrates,

“Like to us,” I said; “for, to begin with, tell me do you think that these men would have seen anything of themselves or of one another except the shadows cast from the fire on the wall of the cave that fronted them?”

Glaucon,

“How could they,” he said, “if they were compelled to

hold their heads unmoved through life?"

Socrates,

"And again, would not the same be true of the objects carried past them?"

Glaucon,

"Surely."

Socrates,

"If then they were able to talk to one another, do you not think that they would suppose that in naming the things that they saw they were naming the passing objects?"

Glaucon,

"Necessarily."

Socrates,

"And if their prison had an echo from the wall opposite them, when one of the passersby uttered a sound, do you think that they would suppose anything else than the passing shadow to be the speaker?"

Glaucon,

"By Zeus, I do not," said he.

Socrates,

"**Then in every way such prisoners would deem reality to be nothing else than the shadows of the artificial objects**."

Glaucon,

"Quite inevitably," he said.

Socrates,

"**Consider, then, what would be the manner of the release and healing from these bonds and this folly if in the course of nature something of this sort should happen to them: When one was freed from his fetters and compelled to stand up suddenly and turn his head around and walk and to lift up his eyes to the light, and in doing all this felt pain and, because of the dazzle and glitter of the light, was unable to discern the objects**

whose shadows he formerly saw, what do you suppose would be his answer if someone told him that what he had seen before was all a cheat and an illusion, but that now, being nearer to reality and turned toward more real things, he saw more truly? And if also one should point out to him each of the passing objects and constrain him by questions to say what it is, do you not think that he would be at a loss and that he would regard what he formerly saw as more real than the things now pointed out to him?"

Glaucon,

"Far more real," he said.

Socrates,

"**And if he were compelled to look at the light itself, would not that pain his eyes, and would he not turn away and flee to those things which he is able to discern and regard them as in very deed more clear and exact than the objects pointed out?**"

Glaucon,

"It is so," he said.

Socrates,

"And if," said I, "someone should drag him thence by force up the ascent which is rough and steep, and not let him go before he had drawn him out into the light of the sun, do you not think that he would find it painful to be so haled along, and would chafe at it, and when he came out into the light, that his eyes would be filled with its beams so that he would not be able to see even one of the things that we call real?"

Glaucon,

"Why, no, not immediately," he said.

Socrates,

"Then there would be need of habituation, I take it, to enable him to see the things higher up. And at first he would

most easily discern the shadows and, after that, the likenesses or reflections in water of men and other things, and later, the things themselves, and from these he would go on to contemplate the appearances in the heavens and heaven itself, more easily by night, looking at the light of the stars and the moon, than by day the sun and the sun's light."

Glaucon,

"Of course."

Socrates,

"And so, finally, I suppose, he would be able to look upon the sun itself and see its true nature, not by reflections in water or phantasms of it in an alien setting, but in and by itself in its own place."

Glaucon,

"Necessarily," he said.

Socrates,

"And at this point he would infer and conclude that this it is that provides the seasons and the courses of the year and presides over all things in the visible region, and is in some sort the cause of all these things that they had seen."

Glaucon,

"Obviously," he said, "that would be the next step."

Socrates,

"Well then, if he recalled to mind his first habitation and what passed for wisdom there, and his fellow-bondsmen, do you not think that he would count himself happy in the change and pity them?"

Glaucon,

"He would indeed."

Socrates,

"And if there had been honors and commendations among them which they bestowed on one another and prizes for the man who is quickest to make out the shadows as they pass and best able to remember their customary precedences,

sequences and co-existences, and so most successful in guessing at what was to come, do you think he would be very keen about such rewards, and that he would envy and emulate those who were honored by these prisoners and lorded it among them, or that he would feel with Homer and "'greatly prefer while living on earth to be serf of another, a landless man,'" [Homer Odysseus 11.489] and endure anything rather than opine with them and live that life?"

Glaucon,

"Yes," he said, "I think that he would choose to endure anything rather than such a life."

Socrates,

"And consider this also," said I, "if such a one should go down again and take his old place would he not get his eyes full of darkness, thus suddenly coming out of the sunlight?"

Glaucon,

"He would indeed."

Socrates,

"Now if he should be required to contend with these perpetual prisoners in 'evaluating' these shadows while his vision was still dim and before his eyes were accustomed to the dark—and this time required for habituation would not be very short—would he not provoke laughter, and would it not be said of him that he had returned from his journey aloft with his eyes ruined and that it was not worth while even to attempt the ascent? And if it were possible to lay hands on and to kill the man who tried to release them and lead them up, would they not kill him?"

Glaucon,

"They certainly would," he said.

Socrates,

"**This image then, dear Glaucon, we must apply as a whole to all that has been said, likening the region revealed through sight to the habitation of the prison,**

and the light of the fire in it to the power of the sun. And if you assume that the ascent and the contemplation of the things above is the soul's ascension to the intelligible region, you will not miss my surmise, since that is what you desire to hear. But God knows whether it is true. **But, at any rate, my dream as it appears to me is that in the region of the known the last thing to be seen and hardly seen is the idea of good**, and that when seen it must needs point us to the conclusion that this is indeed the cause for all things of all that is right and beautiful, giving birth in the visible world to light, and the author of light and itself in the intelligible world being the authentic source of truth and reason, and that anyone who is to act wisely in private or public must have caught sight of this."

Glaucon,

"I concur," he said, "so far as I am able."

Socrates,

"Come then," I said, "and join me in this further thought, and do not be surprised that those who have attained to this height are not willing to occupy themselves with the affairs of men, but their souls ever feel the upward urge and the yearning for that sojourn above. For this, I take it, is likely if in this point too the likeness of our image holds"

Glaucon,

"Yes, it is likely."

Socrates,

"And again, do you think it at all strange," said I, "if a man returning from divine contemplations to the petty miseries of men cuts a sorry figure and appears most ridiculous, if, while still blinking through the gloom, and before he has become sufficiently accustomed to the environing darkness, he is compelled in courtrooms or elsewhere to contend about the shadows of justice or the

images that cast the shadows and to wrangle in debate about the notions of these things in the minds of those who have never seen justice itself?"

Glaucon,

"It would be by no means strange," he said.

Socrates,

"But a sensible man," I said, "would remember that there are two distinct disturbances of the eyes arising from two causes, according as the shift is from light to darkness or from darkness to light, and, believing that the same thing happens to the soul too, whenever he saw a soul perturbed and unable to discern something, he would not laugh unthinkingly, but would observe whether coming from a brighter life its vision was obscured by the unfamiliar darkness, or whether the passage from the deeper dark of ignorance into a more luminous world and the greater brightness had dazzled its vision. And so he would deem the one happy in its experience and way of life and pity the other, and if it pleased him to laugh at it, his laughter would be less laughable than that at the expense of the soul that had come down from the light above."

Glaucon,

"That is a very fair statement," he said.

Socrates,

"Then, if this is true, our view of these matters must be this, that education is not in reality what some people proclaim it to be in their professions.

What they aver is that they can put true knowledge into a soul that does not possess it, as if they were inserting vision into blind eyes."

Glaucon,

"They do indeed," he said.

Socrates,

“But our present argument indicates,” said I, “that the true analogy for this indwelling power in the soul and the instrument whereby each of us apprehends is that of an eye that could not be converted to the light from the darkness except by turning the whole body. Even so this organ of knowledge must be turned around from the world of becoming together with the entire soul, like the scene-shifting periaktos act in the theater, until the soul is able to endure the contemplation of essence and the brightest region of being.

And this, we say, is the good, do we not?”

Glaucon,

“Yes.”

Socrates,

“Of this very thing, then,” I said, “there might be an art, an art of the speediest and most effective shifting or conversion of the soul, not an art of producing vision in it, but on the assumption that it possesses vision but does not rightly direct it and does not look where it should, an art of bringing this about.”

Glaucon,

“Yes, that seems likely,” he said. “Then the other so-called virtues of the soul do seem akin to those of the body. For it is true that where they do not pre-exist, they are afterwards created by habit and practice. But the excellence of thought, it seems, is certainly of a more divine quality, a thing that never loses its potency, but, according to the direction of its conversion, becomes useful and beneficent,”[72]

For Plato, the good beyond being would be the Forms but ‘being’ is in the state of privation. Also, throughout this discussion Plato has an important undercurrent unfolding in the imminent extinction of Athenian democracy. We see this in Plato’s reluctant consignment to the almost unescapable fate of those, humanity,

fettered and watching shadows on the cave walls thinking that the shadows are reality.

> Picture men dwelling in a sort of subterranean cavern with a long entrance open to the light on its entire width. Conceive them as having their legs and necks fettered from childhood, so that they remain in the same spot, able to look forward only, and prevented by the fetters from turning their heads. Picture further the light from a fire burning higher up and at a distance behind them, and between the fire and the prisoners and above them a road along which a low wall has been built, as the exhibitors of puppet-shows have partitions before the men themselves, above which they show the puppets.[73]

Humanity is condemned to shadows and images. These shadows taken as reality portray humanity's origin as chaotic, as fundamental privation, which cannot ever rise to overcome itself. On the other hand, in my view, Plato first espouses the possibility of intelligibility, rationality as, in some circuitous fashion, having the possibility of understanding or acquiring a glimmer of the Forms. This glimmer of hope might have been filled out more by the later histories from his student Aristotle, Christianity, and rationalism. Aristotle disagreed with Plato's notion of the Forms as they were static. Here is a thought, can we find any similarities between privation and the observer effect, branching into classicism from the quantum wave function? …just saying…

The Unmoved Mover

Aristotle took as a founding premise that everything moved. He also had the notion of the unmoved mover. On the surface, we may want to think of this as everything moves = actuality and unmoved mover = potentiality but there is more to it than that.

> In Chapter 6, Book L, of the Metaphysics, Aristotle begins a discussion about "substances." One of the substances he describes is that of an "unmoved mover" which, he argues, exists by necessity and is eternal. For something to be eternal, it is neither created nor destroyed, but always has and always will exist. For something to be a substance, it exists by virtue of itself ("kath'auton") in the sense that its existence is not dependent on anything else--it just is. In contrast, Aristotle describes things that have "accidental" existence ("kata symbebekos") whose existence depends and adheres to an underlying subject.[74]

The previous quote illustrates a problem with many Greek translations. The word translated as “substance” actually comes from Latin (*substantia*) not Greek. So, the phrase tên ousian prôton ti estin Aristotle asks is translated as what is it to be a substance. However, the word ousian comes from the ancient Greek word *ousia* was also incorrectly translated in Latin as essence (*essentia*) or substance (*substantia*). It became a Christian concept in the Latin world as the divine essence of God. However, this transformation obscured the more ancient Greek notion of *ousia (*οὐσία).

> The term οὐσία is an Ancient Greek noun, formed on the feminine present participle of the verb εἰμί, eimí, meaning "to be, I am", so similar grammatically to the English noun "being". There was no equivalent grammatical formation in Latin, and it was translated as essentia or substantia. Cicero coined essentia and the philosopher Seneca and rhetorician Quintilian used it as equivalent for οὐσία, while Apuleius rendered οὐσία both as essentia or substantia. In order to designate οὐσία, early Christian theologian Tertullian favored the use of substantia over essentia, while Augustine of Hippo and Boethius took the opposite stance, preferring the use of essentia as designation for οὐσία. Some of the

most prominent Latin authors, like Hilary of Poitiers, noted that those variants were often being used with different meanings. Some modern authors also suggest that the Ancient Greek term οὐσία is properly translated as essentia (essence), while substantia has a wider spectrum of meanings.[75]

In Aristotle we see that the ultimate, final good may apply to immovable objects. The final good is for something but also the final good at the end of some action (telos). Aristotle writes in what he entitled “Lambda” but Latin scholars entitled, “Metaphysics 12” tells us,

That the final cause may apply to immovable things is shown by the distinction of its meanings. For the final cause is not only "the good for something," but also "the good which is the end of some action." In the latter sense it applies to immovable things, although in the former it does not; and it causes motion as being an object of love, whereas all other things cause motion because they are themselves in motion. Now if a thing is moved, it can be otherwise than it is. Therefore if the actuality of "the heaven" is primary locomotion, then in so far as "the heaven" is moved, in this respect at least it is possible for it to be otherwise; i.e. in respect of place, even if not of substantiality. But since there is something—X—which moves while being itself unmoved, existing actually, X cannot be otherwise in any respect. For the primary kind of change is locomotion, and of locomotion circular locomotion; and this is the motion which X induces. Thus X is necessarily existent; and qua necessary it is good, and is in this sense a first principle. For the necessary has all these meanings: that which is by constraint because it is contrary to impulse; and that without which excellence is impossible; and that which cannot be otherwise, but is absolutely necessary. [76]

Continuing further actuality, which is Aristotle's unmoved mover is inclusive of thinking but not as concept as one pleasure among many. 'Actuality' here is not ultimate Concept but retains a sense of sensuality, enjoyment, pleasures, and is also likened to *theos* which is translated as 'God'. First of all, *theos* was not capitalized. Capitalization was a Latin and later translation implying the Christian God. *Theos* was not monotheistic until the time of Constantine in Rome. *Theos* is singular for god. *Theoi* is plural for gods. Either form could be masculine or feminine.[77] Aristotle continues in Metaphysics 12,

> Such, then, is the first principle upon which depend the sensible universe and the world of nature. And its life is like the best which we temporarily enjoy. It must be in that state always (which for us is impossible), since its actuality is also pleasure. (And for this reason waking, sensation and thinking are most pleasant, and hopes and memories are pleasant because of them.) Now thinking in itself is concerned with that which is in itself best, and thinking in the highest sense with that which is in the highest sense best.] And thought thinks itself through participation in the object of thought; for it becomes an object of thought by the act of apprehension and thinking, so that thought and the object of thought are the same, because that which is receptive of the object of thought, i.e. essence, is thought. And it actually functions when it possesses this object. Hence it is actuality rather than potentiality that is held to be the divine possession of rational thought, and its active contemplation is that which is most pleasant and best.If, then, the happiness which God always enjoys is as great as that which we enjoy sometimes, it is marvellous; and if it is greater, this is still more marvellous. Nevertheless it is so. Moreover, life belongs to God. For the actuality of thought is life, and God is that actuality; and the essential actuality of God is life most good

> and eternal. We hold, then, that God is a living being, eternal, most good; and therefore life and a continuous eternal existence belong to God; for that is what God is. 78

Notice the amplification of marvelous in the quote above. Also, note the strangeness of the Greek mind to the translation onto Latin history. The unmoved mover is pure actuality not something potential. Sensibility and sensation are not the five senses, it is pleasant. The good is not theology it is sensuality, pleasure. All this speaks to embodiment not some doxology. Eternal is *aiőnios* from the Greek word *aiőn* meaning literally age or eon meaning long-lasting, a fixed time period, lasting for life and by extension age of ages, ages of ages, and the like has been translated eternal but that is probably more from the Latin influence. However, the literal interpretation is primarily meant as previously discussed as a quality of *telos*. What does Aristotle mean by the unmoved mover?

Erwin Sonderegger (1942- present) states that the Latin history of Christianity consistently mistranslated ἀκίνητον κινοῦν meaning the first or unmoved mover in Greek to God's knowledge both of himself and the world) or Unmoved Mover as masculine. The Latin preference was given because the Christian God had to be male and first 'substance'.

> It is taken for granted that οὐσία [ousia, being] is both correctly translated with substance and adequately reproduced in its content. But, 'substance' translates ὑπόστασις, not οὐσία, and, it is ὑποκείμενον, subject, that has the function of being the foundation, of being and saying. The translation of Aristotle's οὐσία as 'substance' is not only a wrong translation of the word, but moreover substance does not correspond to what οὐσία means in terms of content either.
>
> The term 'substance' is, as probably all terms, also the first ones, not absolutely given but has a genesis, a history

> which can be reconstructed. However, the origin of this concept does not lie with Aristotle, even if many think so. I can only give some hints on important stations of the origin of the concept of substance, to go into the details would need much more space. The period of its origin reaches very far, from Hippocrates to the Church Fathers, and influences of quite different kind and origin can be found in it. 79

More importantly, the unmoved mover is ***noesis*** *noeseos* or 'awareness of awareness'. In other words, being aware of awareness. From this '**noesis** noeseos **noesis**' would then be 'awareness that is an awareness of awareness'. Often this gets mistranslated as 'thinking that is a thinking of thinking'. Could 'awareness that is an awareness of awareness' also mean consciousness? Sonderegger writes in his article, "Aristotle, Metaphysics Λ: Introduction, Translation, Commentary - A Speculative Sketch devoid God" (note: this is a bit of a hard read),

> A second firm conviction claims that Aristotle advocates a theology whose core consists in a πρῶτον or ἀκίνητον κινοῦν, the "First" or "Unmoved Mover" (with preference in capitals), as the expression is consistently mistranslated masculine. According to the standard interpretation, Aristotle develops a concept of God in Metaphysics Λ with the essential provisions of νόησις νοήσεως and actus purus [pure act, the absolute perfection of God], and that the proof of his existence is given. Aristotle asks, one says, in this text for God as the first substance and he wants to give an existence proof of this primary substance.
>
> In the statement
>
> …καὶ ἔστιν νόησις νοήσεως νόησις,
>
> …and awareness1 is awareness2 of awareness1
>
> [awareness as the structure of the world (awareness1) in which each individual instance of being aware (awareness3)

realizes (awareness2) a certain structure in the world or node in a net]

awareness1 means the structure of a world in which each individual instance of being aware (awareness3) realizes (awareness2) a certain node in a net; the result of this process is that both the perceiving and the perceived are. To be in this way means to enter in a noetic framework (**noesis**1 as awareness1), and this provides the speculative answer to the question of what founds becoming.

If ousia [being] is the heading for the question about being then it can not be translated with substance, it must be understood in the many ways Aristotle registers. At the core of Aristotle's reflection is being, Sein, just as it has been the theme beginning with Parmenides and mediated by Plato's Sophist. In the Metaphysics this question does, of course, take many ramifications. That question includes one additional moment not addressed by Aristotle, one not even made explicit by Plato. Instead, Plato dramatized that moment in the character of the guest from Elea. The question about being is a question which is questioning the questioner himself…

My aim is to call into question the suppositions that Met. Λ has anything to do with theology and that god has an important role to play in this text. Since there are some scholars who agree so far, I would also like to deny that this theology can be replaced by a metaphysics of the substance. Rather, I propose a reading of Met. Λ as a speculative sketch about the meaning of being (ousia, Sein).[80]

For all those interested in this text, the **noesis** noeseos [awareness of awareness] stands at the center of all considerations. Indeed this is a strong common assessment, which I too share. In almost an equal number, on the other hand, are those who concur in understanding this term as denoting 'God's thinking' although this is nowhere in fact

stated in the text. This claim is supported only if the explicit theme of chapter 9, the nous [mind], is implicitly identified with God. That identification would entail the problem that the nous is moved by what it thinks, so it is on the wrong side of the systoichia [a spatial gathering of elements]. That should not be the case for God. Almost all interpreters seem to take the **noesis** in the famous sentence, once as intentio prima [primary intention] then as intentio secunda [secondary intention]. In this case, then, it seems to represent a reflective attitude. In fact the term is employed three times. As far as I can tell, this fact has perturbed no one up to now. The whole phrase reads as follows:

Therefore it <: the nous> thinks itself, if it is the strongest <being>, and <its> thinking is the thinking of thinking.

or, in the translation of D. W. Ross:

Therefore it must be of itself that the divine thought thinks (since it is the most excellent of things), and its thinking is a thinking on thinking.

The standard interpretation takes two occurrences as identical (so one of them can be omitted), and the 'is' as defining. So the phrase means: "The 'thinking of the nous' is to be understood as 'thinking of its own thinking' by definition." Neo-scholastic authors and authors close to them without hesitation give to subvene in the term a personal God (see e. g. the translation by D. W. Ross). In that way nous becomes a conscious subject explicitly. Many authors who do not mention these presuppositions share them too. This conviction is widespread not only in neo-scholastic literature but representatives of philological and historical research hold to it too. All these schools or circles effectively prolong the medieval line of thought…

It is worth noting that the proposals for understanding **noesis** noeseos [thought of thought] offered by the

interpreters never transcend the line of aporias [an expression of deliberation with oneself regarding uncertainty or doubt as to how to proceed] formulated by Aristotle himself in Met. Λ 9: What does the nous think? Does it think something or nothing? Does it always think only itself or other things? If other things, then always the same things or different things in succession? Does it think of accidental things or of beautiful things? Isn't it better not to think of some things at all? All 'solutions' remain within the frame established by these aporias. Met. Λ has been landed in a dense and almost inextricable net of interpretations, which were not seldom expressed through a questionable vocabulary and with an incorrect translation of to proton kinoun. The task now is to trace and understand the thematic references in Met. Λ to other Aristotelian and Platonic texts and to do so without the dogmatic determinations resulting from the history of reception…

This view of the result to be achieved later on should give the background for that which now could seem arbitrary. In the commentary we will find the reasons for this. We normally think of **noesis** [pure intellectual apprehension; for Plato the highest kind of knowledge or knowledge of the eternal forms or ideas] as a thinking of a subject, of a consciousness, of a person. But we have now to think of a **noesis** without a personal subject endowed with consciousness. How are we to speak about **noesis** without asking "Whose **noesis** is this?" We look at the world and see many things. Why is it that we are able to see something? – We see something because we have already seen what there is to be seen, not in detail but in principle. A particular being, which we have seen, activates a network of associations or an order which has been seen before. By this 'before' is meant the basic distinctions, the basic concepts and values of prevailing opinions which go to forming a

world (Grundmeinungen einer Meinungswelt). What is seen before as the world, in this sense: this is the **noesis**1 [awareness]. This **noesis** makes possible another **noesis**, which consists in our particular understanding, seeing, recognizing. We see in actuality what has in fact already been seen as a structure, this is the meaning of **noesis** noeseos [thought of thought]. Finally we are brought to consider that it is not **noesis** that is the final point in Met. Λ, but the sense of to be as {ousia← **noesis** →energeia / Doxa} …

The old gods were already toppled by 384 C. E. in the battle over the altar of Victoria, fought between Ambrosius and Symmachus. Efforts in the 20th century to revive the old gods in a modern manner have failed too. Leaving aside the negative stance adopted against K. Kerényi many scholars were only bemused by W. F. Otto's Die Götter Griechenlands (1929), who tried quite rightly to take seriously the Wirklichkeit der Götter. The history of religion is permitted a rather unconcerned positivism as exemplified by M. P. Nilsson in his work…

Despite the dawn of new research in the 19th century the current understanding of Aristotle remains an understanding determined by presuppositions arising during the Middle Ages, its pillars being substance and realism. In its time this was a good appropriate understanding. It helped people to lead a good life, but it became rigid and stereotypical, without connection to our contemporary world and its exigencies, even leaving aside the fact that the historical correctness of that earlier understanding is open to doubtful reservations. If, interpreting Aristotle, we sustain premises deriving from the Middle Ages, then we maintain an obvious anachronism…

We may well ask why there obtains a permanent dispute over a metaphysics of substance the uselessness to our

context of which is demonstrable? M. Heidegger alone took the effort to articulate and clarify his own hermeneutical situation in relation to Aristotle in his "Phänomenologische Interpretationen zu Aristoteles."4 There is no comparable effort in the historical or philosophical research on Aristotle. Scholars simply assume the validity of their unreflective and immediate understanding and the critique derived from that. Unsuccessfully did P. Natorp argue on the basis of the composition of the Met. Λ that there is no theology to be discerned there. It seems that his thesis finds an opportunity for revival today. R. Bodéüs, has pointed to some dubious basic issues in the standard interpretation, and H. Lang too resists that interpretation. B. Botter reaffirms this doubtfulness about the theological standard interpretation in her investigations of the use of the words theos and theios…

This opening phrase of Met. Λ is far from being the claim "That is so and so," quite otherwise it is the summary of a long-term discourse, in which have participated Presocratics, Sophists, Plato, the Old Academy. The phrase also denotes the method to be followed in that inquiry: theoria. Sometimes theoria means the same as methodos but in Met. Λ it refers to a special method. The word appears only three times in this text, here at the beginning, Λ 1, 1069a18; then at the speculative high point, Λ 7.19, 1072b24; and again at Λ 8.6, 1073b6. Two references are highly exposed, that at the beginning and the occurrence at Λ 7.19, where, as later in the Nicomachean Ethics K 8, 1178b29–32, it is the name for the highest possible realization of us human beings. The second phrase names the respect in which the theme will be treated. The ousiai, the beings, shall be investigated with respect to ousia, Sein, which is their principle and origin. That corresponds exactly with the aim formulated by Theophrastus, in Met. § 1. Further Theophrastus points out that the theme ousia has become urgent in the context of the

question about becoming; and finally he names the same key factor in the present issue as Aristotle does, namely, metabole, change.7 Aristotle says that we have to examine the reasons of becoming (Met. Λ 2.2). It has resulted from the previous investigations that being came to be seen as the first cause of becoming. Thus the next question to be asked is: How can being (Sein) be the first cause of movement? In Met. Λ Aristotle gives an answer in three steps. Being (Sein) is primary in becoming and it is the cause of becoming

1. as actuality (energeia, Met. Λ 6.8), then

2. as a moving cause like a goal which is not moved itself (Met. Λ 7), and finally

3. as **noesis**, awareness, (Met. Λ 7 und 9).

These answers must not be understood as if they had to be added together. What I called 'three steps' is, in fact, to be understood as a climax which makes it possible to understand by speculation what ousia is. Energeia, proton kinoun akineton, **noesis**, "actuality, first unmoved moving, awareness" are three manners of speaking of the same, namely ousia (being, Sein), under three different aspects. [81]

The Greek phrase "καὶ ἔστιν νόησις νοήσεως νόησις" in the previous quote can translate to "and there is an understanding of understanding, an understanding." This intriguing repetition emphasizes the concept of understanding within understanding itself. [82] But I like the way Sonderegger breaks this down. I will come back to this later in the book as well.

I have been using the term 'unmoved mover' because that is a term handed down from centuries after Aristotle that most readers will be familiar with. However, 'unmoved mover' as God has more to do with Latin Christianity and not with Aristotle's meaning of πρῶτον ("First") or ἀκίνητον κινοῦν ("Unmoved Mover"). What does Aristotle tell us about the unmoved mover? Sonderegger asks the question how can ousia or being get associated with the

unmoved mover? Becoming is that actuality of being.

> Aristotle says that we have to examine the reasons of becoming (Met. Λ 2.2). It has resulted from the previous investigations that being came to be seen as the first cause of becoming. Thus the next question to be asked is: How can being (Sein) be the first cause of movement? In Met. Λ Aristotle gives an answer in three steps. Being (Sein) is primary in becoming and it is the cause of becoming
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The unmoved mover was pure actuality. Pure actuality is prior to potentiality (Met. Λ 6.8) for the unmoved mover. The unmoved mover "is totally unmoved and without any potentiality, i.e., pure actuality (Met. Λ 6.8)."[84] Sonderegger continues,

> Aristotle is – by a long and strong tradition – prisoner of a sort of metaphysics which he never dreamed of. This is the result of an interpretation of some of his texts not much later in the Peripatos, but mostly by the fathers and in Middle Ages. In that period such an interpretation was a good one because it stood in connection with everyday life. But now, in the 20th and 21st century we must be aware of the

> incongruity and the ideologic distortion of this interpretation. If we read the text in Greek, not in English, German or otherwise, the fact will be obvious. Most of these translations, as good as they may be, are profoundly imbued with the tradition, the mentality, the conceptions of the Middle Ages.[85]

Just a musing interlude but could wave function collapse and superposition have some similarities with the unmoved mover? Could it be that actuality as a moving cause which is not moved has some similarity to the simultaneity of all possibilities in the quantum wave function which branches with the observer effect into classical awareness? Could there be similarities with what was meant by *ousia* to both individual and historic branching of the wave function's narratives, as ontic, individual narratives of my being, and ontological, historic narratives of Being. Even more so, the observer effect actualizing all simultaneous potentialities into many-world confluences is spookily contrasted with the oddity of the quantum wave function which 'sees' no branching but simply the simultaneous potentials which already included the observer effect. Maybe more simply, the potentiality of the quantum wave function collapses, branches as actuality. In its collapse it moves but in superposition it does not move. Could the wave function then be thought of as a kind of unmoved mover? If so, for Aristotle this then is the good. Could the observer effect be similar to Aristotle's *ousai*, awareness. There is also a long history of debate about whether or not the quantum wave function is ontological or epistemological. In other words, is it real or a vehicle of knowledge? It seems to have both in a spooky sort of way. Could it be that reflective knowing in experience effectively as the quantum wave function, is a kind of awareness of awareness, self-awareness? Remember from the previous quote,

> …καὶ ἔστιν νόησις νοήσεως νόησις,

…and awareness1 is awareness2 of awareness1

[awareness as the structure of the world (awareness1) in which each individual instance of being aware (awareness3) realizes (awareness2) a certain structure in the world or node in a net]

awareness1 means the structure of a world in which each individual instance of being aware (awareness3) realizes (awareness2) a certain node in a net; the result of this process is that both the perceiving and the perceived are. To be in this way means to enter in a noetic framework (**noesis**1 as awareness1), and this provides the speculative answer to the question of what founds becoming. 86

Could it be that,

- awareness as the structure of the world (awareness1) ≅ Quantum wave function
- in which each individual instance of being aware (awareness3) ≅ observer effect, branching or collapse without specifying how the observer effect comes about, e.g., a person, spontaneous, etc.
- realizes (awareness2) ≅ consciousness whether it be human, animal, plant, alien 😉, etc.

Edmund Husserl (1859-1938) is considered the founder of modern phenomenology. I will write more about him later but for now, notice that two very important concepts of Husserl are ***noesis*** and ***noema***.

Husserl introduced two Greek words to capture his version of the Bolzanoan distinction: **noesis** and **noema**, from the Greek verb noéō (νοέω), meaning to perceive, think, intend, whence the noun nous or mind. The intentional process of consciousness is called **noesis**, while its ideal content is

> called **noema**. The **noema** of an act of consciousness Husserl characterized both as an ideal meaning and as "the object as intended". Thus the phenomenon, or object-as-it-appears, becomes the **noema**, or object-as-it-is-intended. The interpretations of Husserl's theory of **noema** have been several and amount to different developments of Husserl's basic theory of intentionality. (Is the **noema** an aspect of the object intended, or rather a medium of intention?) [87]

Husserl is not implying that the content of thought, **noema**, is 'objective' and the 'intentional-izing' act, **noesis,** is not mere subjectivity. He is telling us that these kinds of boundary conditions are abstract and artificial. Think of it analogously more like the wavicle which from the observer effect is a particle, the content of thought, in a field of quantum waves which is more like a smorgasbord of infinite possibilities as in all possibilities in superposition. Aristotle's unmoved mover is more akin to this than the Latin transformation of an omnipresent, omniscient, omnipotent God who stands behind the scenes intervening in actualities in human or cosmic affairs. Later scholastic Latin transformations of Aristotle would associate Aristotle's unmoved mover with the monotheistic God which I think was a massive transformation of Aristotle. It seems to me that Husserl, in keeping with the early 20th century findings of Einstein's relativity found a philosophical way to rethink Aristotle's notion of 'pure actuality' in a more authentic and less abstract fashion. Actuality is not the abstract notion of simple movement. Lived actuality is not sheer 'movement'. Lived actuality is always as an intention towards <fill in the blank>. Lived actuality intends towards some object, some goal, some perception. Even as sheer hallucinations, Husserl would still find this dynamic at work.

In Aristotle's use of the word *energeia* there is the idea of propulsion, some actional intention. Additionally, the intention 'towards'… has some goal, some object, some idea of where it is

directed – can we harken back to the discussion on Aristotle's *telos*? In the lived action of 'intention towards' the goal is not moved. Sure, it can change to another goal but then that goal becomes the unmoved mover. The 'intention towards' is ***noesis***. The goal is ***noema***. Sonderegger after Heidegger tells us the goal or object of intention is direct towards Being, towards what 'is'. But Husserl later will tell us that sometimes 'intention towards' can be mistaken in its goal. If we are walking on a path and see a snake, we jump away, only to find that it was a stick meaning we had an intention to not get bitten by a snake but then the object turned out to be something different than we intended. Intention towards <fill in the blank> also intends a certain lived temporality and spatiality, a certain quality of existence or Being that is teleological. But the lived practicality of the intention does not make it so, make it absolute, make it true. So, for Husserl phenomenology was about bracketing our beliefs from acquired habitual intentions and simply opening up the possibility that the objects of our intentions may not 'be' the truths we assume them to 'be'.

To recap,

Socrates tells us,

> it is right to deem light and vision sunlike, but never to think that they are the sun, so here it is right to consider these two their counterparts, as being like the good or boniform, but to think that either of them is the good is not right. Still higher honor belongs to the possession and habit of the good.
>
> Glaucon responds,
>
> "An inconceivable beauty you speak of," he said, "if it is the source of knowledge and truth, and yet itself surpasses them in beauty. For you surely cannot mean that it is pleasure."
>
> Socrates replies,
>
> "Hush," said I, "but examine "In like manner, then, you are to say that the objects of knowledge not only receive

from the presence of the good their being known, but their very existence and essence is derived to them from it, though **the good itself is not essence** but still transcends essence in dignity and surpassing power."

Glaucon responds,

And Glaucon very ludicrously said, "Heaven save us, hyperbole can no further go."

Socrates replies,

"The fault is yours," I said, "for compelling me to utter my thoughts about it."

This is Socratic humor.

Finally, Socrates replies,

"This image then, dear Glaucon, we must apply as a whole to all that has been said, likening the region revealed through sight to the habitation of the prison, and the light of the fire in it to the power of the sun. And if you assume that the ascent and the contemplation of the things above is the soul's ascension to the intelligible region, you will not miss my surmise, since that is what you desire to hear. But God knows whether it is true. But, at any rate, my dream as it appears to me is that in the region of the known the last thing to be seen and hardly seen is the idea of good, and that when seen it must needs point us to the conclusion that this is indeed the cause for all things of all that is right and beautiful, giving birth in the visible world to light, and the author of light and itself in the intelligible world being the authentic source of truth and reason, and that anyone who is to act wisely in private or public must have caught sight of this." [88]

Here 'the good' is that 'seeing' must point us to the conclusion that there must be a cause for all things, a cause of all that is right and beautiful, a giving birth in the visible world to light which is the author of light and the author for the intelligible world and

being the authentic source of truth and reason, and anyone who is to act wisely in private or public must have caught sight of this. The good is what gives birth to light. The good transcends existence and essence as objects of knowledge not only receive from the presence of the good, their being known, but objects' very existence and essence are derived from the good, though the good itself is not essence but still transcends essence in dignity and surpassing power. For Socrates the "cause of all things" which gives birth to light and the visible world is 'the good' beyond Being and what Plato calls the Forms.

Note here that light and presence has not yet overtaken the good as privation. This means that the good is not only light and presence but also the absence of light and what does not come into presence. Privation still reflects the unknowing of the earlier Ionian's unlimited (*aperion*), flux, and chaos. Also, note that soon after with Aristotle *aperion* begins to disassociate affirmative older ideas of Greek flux and chaos in associations of more negative connotations of logical negation and contradiction.

> What sort of operation is negation? In the Categories and De Interpretatione, Aristotle partitions indicative-mood declarative sentences into affirmation and negation/denial (apophasis from apophanein "deny, say no"), which respectively affirm or deny something about something. As a mode of predication, the predicate denial of Aristotelian term logic, while resulting in wide-scope negation opposed in truth value to the corresponding affirmative, is syntactically distinct from the unary "it is not the case that" connective of Stoic and Fregean logic.[89]

In a much earlier period of the Greeks, in Hesiod, we have Uranus (father sky) and Gaia (mother earth). Sky suspends, stands off, provides perspective. Sky is the son and husband of earth. Therefore, earth is generative. As the first of the gods, Earth is yet

to be differentiated, it is undifferentiated. Earth is the origin of sky. Thus, Earth is *arche* or origin. In Hesiod, Earth was the first of the gods. Yet, Hesiod's Muses tells us that first of all was *khaos*, chaos. Chaos means the 'yawning gap', a void. Thus, chaos differentiates and separates (the heaven and the earth). Earth is permeated through and through with chaos, undifferentiated but fertile and generative.[90]

But later and increasingly, *peras* or form has been transformed from boundary or limit in the sea of unlimited (*aperion* -> unlimited, without form, void, chaos filling privation) towards conditions of negation and noncontradiction. Almost unnoticed, the 'good beyond being' will eventually be driven towards an ethics (*ethos*) of logic which becomes the foundation of rationalism. The good has become the greater good determined by rationality, by ratio and proportion. Additionally, Being as emerging from presence equates to existence. Uncertainty moves towards certainty. Note that ethics has been understood in terms of presence as what shows itself from a history which already displaces and without notice assumes place of the other as Being, as already understood, in terms of conditions set by the history of rationalism.

> In Eros we can begin to understand that classic Greek thinking is not merely the transition from mythos to logos. The Greeks understood and puzzled deeply over emotion, simple sensations, love, concern, affection, sexual intimacy. When they thought of privation, withdrawal, infinite deeps of Darkness and deep Abyss with dark Chaos they assumed Love or Desire as a first principle in things. The distance with which much of modern scholarship has approached classic antiquity reflects more on the 'transformation of the interpretation' than the infinite proximity of the texts which remain and in doing so has denied the excess of proximity to origin, my origin and the chaotic gap, the disruption of origin (which in no wise should be leveled off into mere

neutrality, *il y a*). [91]

The inability of Greek mythos to resolve itself sets up a perpetual strife in the early Greek *psuchê* or psyche. The lack of cosmogonic resolve in Hesiod's earliest moment of chaos reflects an unsettled disruption that fuels the inquiry of *phusis*, drama, sculpture, and poetry which was inspired by an unaccounted-for excess not in affirmation but in the richness of lack, privation (*steresis*) unsettled by the twilight of chaos. Privation could not yet find a finality in negation but overflowed as contingent desire *orexis* [92] and haunted us in what later became the passion play of metaphysics and still haunts us even to this day.

Interesting to note that boundary conditions abound in quantum mechanics not as barriers but as truncations of infinites which highlight, draw a circle on the face of infinites, a particular *telos*, an experimental goal of observation. As quoted previously, Matsuno writes,

> Thus subsequent internal boundary conditions (of which initial conditions are only a special case) are inseparable from the internal quantum dynamics. Boundary conditions, well-known in Newtonian mechanics, are thus an integral part of the internal quantum dynamics. The ''observers'' are, in this way, internally specified and fused with the dynamics. [93]

Truncations, approximations, limits are not absolutes but contingents of observation. This is the yes/no of Wheeler's 'it from bit' which obliges astute observations but owns no necessity to judgements derived thereof. For Plato Form has no boundary as *apeiron*, the excess of 'not', of shadows on our cave walls.

For Plato, language can only show origin based on privation, its absolute inability to be able as the good, as love. This is not negation as we think in the modern sense. It is the highest virtue

and service language provides us. We can know what is not as in the limit of which *apeiron* refers in its 'a' of privation to the Forms. Limit certainly plays a role in *apeiron* but only to make way for what it cannot be, cannot come into existence. 'What the Forms cannot be from *steresis* (privation) is what being as such cannot be. It is what 'Idea' cannot think. It is an excess which cannot be neuter, cannot be extinguished in light, reason and thought. For Plato, the good can only be faced in privation. Privation exceeds the 'not' of interiority. Privation ever flows towards exteriority which finds no footing in interiority and its exclusive or inclusive middle of logic. For Levinas, exteriority cannot maintain this bipolar duality. In attributing the good as love we have supplemented exteriority with the human face; the he or she who faces us in their radical exteriority.[94]

Additionally, note here that falsity also remains in itself as a deprived mode of truth often erroneously taken as an opposite. However, falsity can only *be* what it *is* as a contrary distinction to truth, as a circle drawn on the face of infinites which connote an inside and an outside. Falsity is essentially dependent on truth to be what it is just as contradiction is necessarily related to identity and truth, non-contradiction – dialectical opposition. This also means that truth can only assert itself as what it isn't in its falsity. Therefore, truth and falsity are both known as such in privation, a lack of what they are when taken as mere opposites, shadows on the cave walls. For Plato, for the forms to be what they are, to remain in themselves as separate and essentially dependent, they must remain as privation, as excess which cannot be gathered into presence and absence. In the historic dialectic which follows the Greeks, light is only known through darkness, good is only known through bad, etc. Only by the essential 'not' and 'knot' of binary oppositions can Truth make its eternal claim. Truth remains in logos as an essential condition for sight, for logic to assert its priority in its isolation or perhaps clearing for later Heidegger. Specifically, the essential condition for sight, for logic, we refer to

as being or ontology, as the essential pillar of language which must erase its trace of/as essence. This is found in the copula which founds all possibilities of thinking, writing, and the repetitious 'foundings' of narratives which long ago lost any trace of an anarchic excess to origin. Ontology in this case is what sifts and retains identity from Hesiod's random chaos (χάος), what allows itself as 'must' and 'can' only showing itself in the clearing of light.[95] The good as other than Being, existence, comprehension, logic and rationality from the early Greeks long ago left excess, uncertainty, the without of deterministic causality. What other possibilities can we think of in Aristotle's non-being as privation? Could we think a "passivity prior to receptivity" thought as non-being?[96] Richard Cohen, a Levinasian scholar, writing about origin states:

> How can what has not yet begun be continued? Can there be a beginning prior to the origin? If being has an origin, as philosophy has always maintained (regardless of whether philosophy can or cannot discover that origin), then what is the sense of "is" when one says that "there is a beginning prior to the origin"? Such a beginning would already be a challenge to the firstness of first philosophy, would already be a challenge to the "is" that attempts to discover its origin, of itself, by itself, courageously, invoking all of history and nature if that is what it takes to be free of outside help.[97]

The question of origin was a primary concern for the ancient Greeks and confluences from many other ancient civilizations.[98] This was long before Latin Christianity and 'metaphysics' in Roman Constantinople. Aristotle's works called 'Metaphysics' by early Latin writers is quite misleading to the ancient Greek mind.

> The word 'metaphysics' is notoriously hard to define. Twentieth-century coinages like 'meta-language' and

> ‘metaphilosophy’ encourage the impression that metaphysics is a study that somehow “goes beyond” physics, a study devoted to matters that transcend the mundane concerns of Newton and Einstein and Heisenberg. This impression is mistaken. The word ‘metaphysics’ is derived from a collective title of the fourteen books by Aristotle that we currently think of as making up “Aristotle’s Metaphysics.” Aristotle himself did not know the word. (He had four names for the branch of philosophy that is the subject-matter of Metaphysics: ‘first philosophy’, ‘first science’, ‘wisdom’, and ‘theology’.) At least one hundred years after Aristotle’s death, an editor of his works (in all probability, Andronicus of Rhodes) entitled those fourteen books “Ta meta ta phusika”—”the after the physicals” or “the ones after the physical ones”—, the “physical ones” being the books contained in what we now call Aristotle’s Physics. The title was probably meant to warn students of Aristotle’s philosophy that they should attempt Metaphysics only after they had mastered “the physical ones,” the books about nature or the natural world—that is to say, about change, for change is the defining feature of the natural world.[99]

Aristotle’s investigations into physics were an essential part of his overall study of *phusis,* part of which we now call physics and metaphysics in a reductionary, contrarian fashion. An excess implied in ancient Greek thought to *phusis* will be hinted at in this book. This excess is also hinted at in Andronicus of Rhodes description of Aristotle’s works as “*the after the physicals” or “the ones after the physical ones*”. Here the ‘after’ is thought in terms of what does not show itself as physical but is the completion or fulfillment of the physical (*telos*). In the Greek mode of thinking the completion or fulfillment was the beginning and end, the final purpose or goal, and what we might think as what makes the physical, actuality, possible - emphasizing the necessity of origin.

Even now physics has pursued Aristotle's notion of origin as cosmology.

The Big Bang, Big Bounce, and Big Crunch asks after the origin and Aristotle's concern. Even evolution looks for hints about the origin of life and the conditions which made it possible. The more proper notions of metaphysics in Latin Christianity such as God, Genesis, heaven, and hell were all irrelevant and unknown to Aristotle's inquiry. Much of my "Philosophy Series" has to do with the ancient Greek inquiries into origin.[100] In this discussion I want to continue towards the notion of origin in terms of recent findings in quantum physics. One important distinction I want bring out in this book is that origin necessarily implies cause and effect. For Aristotle movement or motion requires potentiality and actuality or cause translated to effect. Aristotle tells us in Metaphysics,

> It is the principles and causes of the things which are that we are seeking; and clearly of the things which are qua [as] being. There is a cause of health and physical fitness; and mathematics has principles and elements and causes; and in general every intellectual science or science which involves intellect deals with causes and principles, more or less exactly or simply considered. But all these sciences single out some existent thing or class, and concern themselves with that; not with Being unqualified, nor qua Being, nor do they give any account of the essence ['first philosophy', 'first science', 'wisdom', and 'theology']; but starting from it, some making it clear to perception, and others assuming it as a hypothesis, they demonstrate, more or less cogently, the essential attributes of the class with which they are dealing. Hence obviously there is no demonstration of substance [being] or essence [first principle] from this method of approach, but some other means of exhibiting it. And similarly they say nothing as to whether the class of objects with which they are concerned exists or not; because the

> demonstration of its essence and that of its existence belong to the same intellectual process. And since physical science also happens to deal with a genus of Being (for it deals with the sort of substance which contains in itself the principle of motion and rest), obviously it is neither a practical nor a productive science. For in the case of things produced the principle of motion (either mind or art or some kind of potency) is in the producer; and in the case of things done the will is the agent—for the thing done and the thing willed are the same. Thus if every intellectual activity is either practical or productive or speculative, physics will be a speculative science; but speculative about that kind of Being which can be moved, and about formulated substance for the most part only qua inseparable from matter. But we must not fail to observe how the essence and the formula exist, since without this our inquiry is ineffectual.[101]

Here, Aristotle is asking the question of essence, *ousia,* which has haunted humans from our earliest beginnings, "What is the origin". But in thinking *ousia* as Aristotle does, we still must think it as being, as boundary, not as later Latin metaphysics of essence. Unfortunately, origin has been subducted to also mean 'by authority' and 'by rule' as a signet and seal of legitimacy. Through subsequent histories boundary implies binary totalities, absolute certainties, and all the mechanisms from which power originates and maintains itself. However, from the earliest Greek thinkers we find Hesiod in 700 BC telling us in the Theogony,

> Hail, children of Zeus! Grant lovely song and celebrate the holy race of the deathless gods who are for ever, those that were born of Earth and starry Heaven and gloomy Night and them that briny Sea did rear. Tell how at the first gods and earth came to be, and rivers, and the boundless sea with its raging swell, and the gleaming stars, and the wide heaven

above, and the gods who were born of them, givers of good things, and how they divided their wealth, and how they shared their honors amongst them, and also how at the first they took many-folded Olympus3. Tell me all of this, you Muses who have your homes on Olympus, from the beginning [archê, ἀρχῆς], tell who first of them (the gods) came-to-be [genet', γένετ᾽].

First of all Chaos came-to-be [genet', γένετ᾽]; but then afterwards Broad-breasted earth, a secure dwelling place forever for all [the immortals who hold the peaks of snowy Olympus], and misty Tartara in the depths under the wide-wayed grounds and Eros who, handsomest among the deathless gods a looser of limbs, in all the gods and in all human beings overpowers in their breasts their intelligence and careful planning. And from Chaos came-to-be both Erebos [ρεβος, the god of deep darkness, shadow] and dark night, and from night, in turn, came-to-be both Aither [the god of upper air, the mist of bright, glowing light, home of the gods] and day, whom she conceived and bore after joining in love with Erebos. But earth first begat, as an equal to herself, starry sky, so that he might cover her on all sides, in order to be a secure dwelling place forever for all the blessed gods, and she begat the tall mountains, pleasing haunts of the goddess-nymphs who make their homes in the forested hills, and also she bore the barren main with its raging swell, the sea, all without any sweet act of love; but then next, having lain with sky, she bore deep-swirling ocean" 102

Chaos, better translated as yawning gap, was before the gods. Origin is not God or gods. It is not any kind of induction of authority or rule. Origin as chaos is gap which cannot be bridged, given footing in history and language. Authenticity and sovereignty find no shelter or retreat to/in/as, origin. In this sense our notions

of origin are not original meaning what dominated early Greek thought and other ancient cultures until later, more prevalent notions, in later thinkers perhaps barely beginning in Aristotle. Moreso, origin as authority or rule was not the notion Aristotle was articulating in the books of 'Metaphysics'. It was anarchic with regard to rule or authority. Greek thinkers shortly after Hesiod would call this *apeiron* (ἄπειρον) meaning unlimited, boundless, infinite, indeterminate. *Apeiron* is the negation (ἀ) of *peirar* (πεῖραρ) or end, limit, boundary. *Apeiron* is more like the fertile void of Buddhism denoted by *Śūnyatā*. While the term origin has been subducted by language and history as order, rule, God. etc., origin in the most ancient Greek thought was permeated with tones of what we think as anarchic, as chaos, yawning gap, apeiron. Many ancient civilizations including the Hebrew account of Genesis which states "the earth was without form and void"[103] have also echoed this contrarian view from popular religious and secular opinions. Contemporaneously, if origin was the Big Bang, what came before that?

If origin was the Big Bounce where the expansion and subsequent compression of the universe results in another Big Bang, what came before all the bounces? According to the earliest ancient Greeks and many cosmological myths, the cosmos finds its beginning and end, its form, boundary, and limit in indeterminacy. Cause and effect must have a chain of beginnings and ends from which determinacy is achieved. However, the question of cause and effect necessarily implies something of a vastly different kind or order than an endless chain of causal relations. Aristotle recognizes this as the unmoved mover *not* as God. The question of cause and effect necessarily requires a notion of origin which has no external determinacy or dependence, no beginnings before the beginning, no prior cause meaning not subject to time or space. Classical physics is absolutely deterministic with regard to cause and effect.

As Aristotle deduced, any physics which asks the question of origin, cause and effect, and motion must necessarily require

something very different with regard to its essence (*ousia*) which implies it cannot be subject to time and space or an endless chain of cause and effect which for Aristotle was the unmoved mover – now we can state, it requires indeterminacy, quantum mechanics. The idea of eternal cause and effect does not seem to suffice for the essential terms required by the question of origin. Origin is a Gordian Knot which cannot be untied, a riddle which cannot be solved. Aristotle continues his inquiry in book 12 of Metaphysics,

> That the final cause may apply to immovable things is shown by the distinction of its meanings. For the final cause is not only "the good for something," but also "the good which is the end of some action." In the latter sense it applies to immovable things, although in the former it does not; and it causes motion as being an object of love, whereas all other things cause motion because they are themselves in motion. Now if a thing is moved, it can be otherwise than it is. Therefore if the actuality of "the heaven" is primary locomotion, then in so far as "the heaven" is moved, in this respect at least it is possible for it to be otherwise; i.e. in respect of place, even if not of substantiality. But since there is something—X—which moves while being itself unmoved, existing actually, X cannot be otherwise in any respect. For the primary kind of change is locomotion, and of locomotion circular locomotion; and this is the motion which X induces. Thus X is necessarily existent; and qua necessary it is good, and is in this sense a first principle. For the necessary has all these meanings: that which is by constraint because it is contrary to impulse; and that without which excellence is impossible; and that which cannot be otherwise, but is absolutely necessary. [104]

As Aristotle deduced, any physics which asks the question of origin, cause and effect, and motion must necessarily require a

different kind of *ousia* meaning indeterminacy with regard to *ousia* as causal. This implies it cannot be subject to time and space or an endless chain of cause and effect. Before I go any further, let's clarify the terms 'essence' and indeterminacy in the previous sentence.

By 'indeterminate' I mean not finite or mutable, a product of change or for Aristotle, motion. Mutability implies change which implies determinacy and cause. However, for Aristotle "*motion cannot be either generated or destroyed, for it always existed; nor can time, because there can be no priority or posteriority if there is no time.*" Aristotle tells us in "Metaphysics" Book 12,

> Thus we have stated what the principles of sensible things are, and how many they are, and in what sense they are the same and in what sense different.
>
> Since we have seen that there are three kinds of substance, two of which are natural and one immutable, we must now discuss the last named and show that there must be some substance which is eternal and immutable. Substances are the primary reality, and if they are all perishable, everything is perishable. But motion cannot be either generated or destroyed, for it always existed; nor can time, because there can be no priority or posteriority if there is no time. Hence as time is continuous, so too is motion; for time is either identical with motion or an affection of it. But there is no continuous motion except that which is spatial, of spatial motion only that which is circular. [105]

And again,

> That the final cause may apply to immovable things is shown by the distinction of its meanings. For the final cause is not only "the good **for something**," but also "the good which is **the end of some action**." In the latter sense it applies to

> immovable things, although in the former it does not; and it **causes motion as being an object of love**, whereas all other things cause motion because they are themselves in motion. Now if a thing is moved, it can be otherwise than it is. Therefore if the actuality of "the heaven" is primary locomotion, then in so far as "the heaven" is moved, in this respect at least it is possible for it to be otherwise; i.e. in respect of place, even if not of substantiality. But since there is something—X—which moves while being itself unmoved, existing actually, X cannot be otherwise in any respect. For the primary kind of change is locomotion,[1] and of locomotion circular locomotion; and this is the motion which X induces. Thus X is necessarily existent; and qua necessary it is good, and is in this sense a first principle. For the necessary has all these meanings: that which is by constraint because it is contrary to impulse; and that without which excellence is impossible; and that which cannot be otherwise, but is absolutely necessary.[106]

By the previous use of my term ‘indeterminacy’ I am referring to Aristotle’s argument here where he makes the case that cause and effect cannot be a sufficient explanation in itself. In our colloquialism we might think what came first, the chicken or the egg? Aristotle’s unmoved mover is the first cause (genesis as uncaused, as anarchy exceeding the ‘not’ of causal origins). Aristotle was fully aware that his unmoved mover was more of what we now would call a ‘theological’ issue.

> In Book E, Aristotle adds another description to the study of the causes and principles of beings qua beings. Whereas natural science studies objects that are material and subject to change, and mathematics studies objects that although not subject to change are nevertheless not separate from (i.e., independent of) matter, there is still room for a science that

> studies things (if indeed there are any) that are eternal, not subject to change, and independent of matter. Such a science, he says, is theology, and this is the "first" and "highest" science. Aristotle's identification of theology, so conceived, with the study of being qua being has proved challenging to his interpreters.[107]

Let's recall the ancient Greek history which Aristotle was fully aware of from Hesiod to Anaximander and many others before him concerning chaos and night in Greek mythology. Further in the previous section I quoted he tells us in his Metaphysics,

> Therefore Chaos or Night did not endure for an unlimited time, but the same things have always existed, either passing through a cycle or in accordance with some other principle—that is, if actuality is prior to potentiality. Now if there is a regular cycle, there must be something[3] which remains always active in the same way; but if there is to be generation and destruction, there must be something else[4] which is always active in two different ways. Therefore this must be active in one way independently, and in the other in virtue of something else, i.e. either of some third active principle or of the first. It must, then, be in virtue of the first; for this is in turn the cause both of the third and of the second. Therefore the first is preferable, since it was the cause of perpetual regular motion, and something else was the cause of variety; and obviously both together make up the cause of perpetual variety. Now this is just what actually characterizes motions; therefore why need we seek any further principles?[108]

It seems Aristotle was content to leave the matter of the unmoved mover as not in time or space and not the cause of anything else. Later history would define the notion of 'not in time

and space' and 'uncaused' as eternal. However, the early Greeks did not have the idea of 'eternity' as we do. The word in Greek was *αἰών* which in this context in the earlier Greek period meant an age or a limited span of time. In the later classical and late antique periods [3rd to 7th century AD] it may have taken on the metaphysical idea of eternity or at least ages of ages.[109]

Can we associate these notions with the quantum wave function, at least perhaps in some whimsical fashion? The wave function is not static, is not absolute, determinate, is not origin and not even that 'not'. It moves but is not moved upon. It exceeds from all its branchings not from Frankenstein's graveyards of body parts but from an excess which moves everything but is not moved by anything. The wave function as pure actuality becomes potentiality for the observer which actuates into classical narratives, as *ousia*. *Ousia* as Being is the culmination of space and time, of worlding, not the mechanics of body parts which can be alchemically transformed onto life. Let's focus more on temporality, not our contemporaneous idea of temporality but a much earlier notion of temporality, as eon, as age.

For early Greeks, an age was a specific duration of time which had a beginning and an end. It could also be used for very short durations of time like a day or a lifetime. The Greeks used many ideas of time and ages moving in phrases like 'ages of ages' which could be more like epochs. It could also be used for an indefinite period of time.

> According to scholar David Bentley Hart: "Much depends, naturally, on how content one is to see the Greek adjective αιωνιον, *aionios*, rendered simply and flatly as "eternal" or "everlasting." It is, after all, a word whose ambiguity has been noted since the earliest centuries of the church. Certainly the noun αἰών, aion (or aeon), from which it is derived, did come during the classical and late antique periods to refer on occasion to a period of endless or at least

indeterminate duration; but that was never its most literal acceptation. Throughout the whole of ancient and late antique Greek literature, an "aeon" was most properly an "age," which is simply to say a "substantial period of time" or an "extended interval."[110]

Here are other early meanings of *αἰών*,

In early Greek αἰών means ‘life’ (often in the sense of ‘vital force’), ‘whole lifetime’, ‘generation’. It was perhaps through application to the *kosmos*, the lifetime of which is never-ending, that the word [later] acquired the sense of eternity.[111]

On essence…

Aristotle turns in Z.4 to a consideration of the next candidate for substance: essence. (‘Essence’ is the standard English translation of Aristotle’s curious phrase to ti ên einai, literally “the what it was to be” for a thing. This phrase so boggled his Roman translators that they coined the word essentia to render the entire phrase, and it is from this Latin word that ours derives. Aristotle also sometimes uses the shorter phrase to ti esti, literally “the what it is,” for approximately the same idea.) In his logical works, Aristotle links the notion of essence to that of definition (horismos)—“a definition is an account (logos) that signifies an essence” (Topics 102a3)—and he links both of these notions to a certain kind of per se predication (kath’ hauto, literally, “in respect of itself,” or “intrinsically“)—”what belongs to a thing in respect of itself belongs to it in its essence (en tôi ti esti)” for we refer to it “in the account that states the essence” (Posterior Analytics, 73a34–5).[112]

The phrase *'to ti ên einai' did not just boggle* Roman translators. It has been the subject of many philologists who study these texts in the original Greek but also many philosophers after Aristotle, not the least of which was Martin Heidegger. Suffice it to say that this is a very involved technical area of philosophy. I point this out here just to make an explicit note that the translations into 'essence' and 'substance' is an important limitation of the Latin world which did not apprehend the depth of Greek thought. However, this limitation played a significant role in Western history which followed. All of this will come back in later parts of this book when Levinas and radical alterity play a very different role than what the end of the Classical Greek period and beyond fashioned as the good.

A Deeper Dive - In the Beginning, the Metaphysics of Eternity was Not

A typical Latin or later Greek anachronism (Christian doxa) which gets imputed to the earlier ancient Greek mind is the idea of eternity. While the idea of 'eternity' may have helped the early Catholic church become 'universal' against competing factions of Christianity (as Elaine Pagels discusses in her book, "The Gnostic Gospels"), it obscured earlier Greek ideas. Even in some English translations of Greek passages quoted in this book, the anachronistic derivation '*aeon' (also eon, aon, age, epoch)* of the adverb root '*aei'* is translated as eternity or eternal.

In 'ETERNITY' REVISITED A Study of the Greek Word *αἰών* Heleen Keizer concludes,

> Discerning as I do in the (extra-biblical) meaning of aiôn three notions, I have described the first as 'life', the second as 'time', and the third variously as 'whole', 'completeness', 'totality', or 'entirety'. The third notion distinguishes aiôn when used as a word for 'life' from the other words zôê and bios, and when aiôn is used as a word for 'time' this notion adheres to its meaning no less. Aiônis the 'entirety' of time;

‘eternity’ is too much an ‘anachronistic’, misleading or unclear rendering.[113]

In 1880 John Hansen wrote,

"We submit the following derivation of aion, to which we invite the scrutiny of scholars:—In Greek a noun with accented omega (long o) in the last syllable of the nominative case singular, signifies a container; that is, the on indicates that the preceding syllable is contained in it. Thus, a Greek's loutr-dn is his bath-place ; a dendr-dn is his grove-place ; a rhod-dn is his rose-place, etc. An aion is, therefore, something that contains an aei, or aia—a something containing the earth, aia', or duration, aei; or breathings, ad; existence, life;—duration, signified by breathings, is perhaps the best etymology of the word.[114]

In the Wiktionary excerpt below many of the definitions through history for the Greek words *αεί* and αἰών are shown:

ἀεί

See also: αεί, αει- and αεί-

Ancient Greek

Alternative forms

αἰεί (aieí) – Epic, Ionic, poetic

αἰέν (aién) – Homeric

ἀέ (aé), ἀές (aés), αἰές (aiés), αἰή (aié) – Doric

αἰέ (aié) – unknown

αἶι (aîi) – Aeolic

ᾐ (ēi) – Boeotian

αἰϝεί (aiweí) – Delphic

Etymology

From Proto-Hellenic *aiweí, from Proto-Indo-European *$h_2$eyu- (“lifetime, long time”), ultimately from Proto-Indo-

European *$h_2$ey- (“vital energy, life”). Equivalent to locative case of αἰών (aiṓn), with or without the -ν.

Adverb

ἀεί or ἄεί • (āeí or aeí) (Attic)

(at all times): always, ever

Synonym: πάντοτε (pántote)

Νῦν καὶ ἀεί.

Nûn kaì aeí.

Now and always.

(for all time): forever, everlastingly, infinitely

Synonyms: διὰ παντός (dià pantós), διὰπαντός (diàpantós)

(for (an) eternity): eternally

(for an indefinitely long period of time, without specification regarding past present or future): abidingly, at length, indefinitely, in perpetuity, lengthily, perpetually

(for an indefinitely long period of time including the present time): for the time being

(for an indefinitely long period of time including a specific point in time (generally in the past) which is not the present time): at that time, at the time; back then

(at all times from a distant past through the present or some other time): from the get-go, from the start, heretofore, since the beginning, to date, up to now, until this day, "jusqu'aujourd'hui"; theretofore

(at all times from the present or some other time through a distant future): endlessly, evermore, forevermore

Usage notes

Remaining true to its Indo-European root, the adverb ἀεί imparts the sense that a verbal action occurs continuously for "a long time" in a variety of specifications, or indeed for all time. When specifying a temporally bounded period of time, ἀεί may refer to an action occurring: either from the far past through the present, from the present until a distant future,

for a relatively long time in either the past or in the future, or from the far past through a distant future. Contrast πώποτε (pṓpote), which (where not negated) indicates that a verbal action might occur at any time over a long period of time, but not necessarily continuously.

Descendants

Greek: αεί (aeí)[115]

αἰών

See also: Αἰών

Ancient Greek

Etymology

From earlier αἰϝών (aiwṓn), from Proto-Indo-European *$h_2$eyu- (“vital force, life, long life, eternity”), whence also ἀεί (aeí, “always”). Cognate with Latin aevum, English aye.

Pronunciation

IPA(key): /ai̯.ŏː.n/ → /ɛˈon/ → /eˈon/

Noun

αἰών • (aiṓn) m (genitive αἰῶνος); third declension

lifetime

generation

a long period of time, eon, epoch, age

the current world

eternity

Inflection

Third declension of ὁ αἰών; τοῦ αἰῶνος (Attic)

Synonyms

καιρός (kairós)

χρόνος (khrónos)

Derived terms

αἰώνιος (aiṓnios)

Descendants

English: aeon, eon

Greek: αιώνας (aiónas)

Latin: aeon [116]

Alchemy and the Royal Society

From the Latin transformation of *phusis* into substance we are beginning to acquire the modern idea of the mind/body 'thinking/ thing' of Descartes blossoming in the history of Enlightenment. [117] This distance the ancient Greeks had from our modern-day notions of neutrality, the 'it', gave the Greeks from the epic writers to Plato and Aristotle a more unsettled and richer inquiry into *phusis.* The emergence of neutrality showed itself in Newton's writings. However, even then, Newton wrote extensively about God and alchemy - the chemical 'transubstantiation' of base metal into gold which dominated until its demise from England's Royal Society.[118] As late as the 20th century Maurice Blanchot writes of the insidious abstraction of neutrality which levels off our relations with others. In "The Gaze of Orpheus" Maurice Blanchot's essay "The Narrative Voice" tells us,

> "What Kafka teaches us – even if this expression cannot directly be attributed to him – is that storytelling brings the neuter into play. Narration governed by the neuter is kept in the custody of the "he", the third person that is neither the third person, nor the simple cloak of impersonality. The "he" of narration in which the neuter speaks is not content to take the place usually occupied by the subject, whether the latter is a stated or implied "I" or whether it is the event as it takes place in its impersonal signification. The narrative "he" dismisses all subjects, just as it removes every transitive action or every objective possibility. It does this in two forms: 1) the speech of the tale always let us feel that what is being told is not being told by anyone: it speaks in the neuter; 2) in the neuter space of the tale, the bearers of speech, the subjects of the action- who used to take the place of characters – fall into relationship of non-identification with themselves: something happens to them, something

> they cannot recapture except by relinquishing their power to say "I" and what happens to them has always happened already: they can only account for it indirectly, as self-forgetfulness, the forgetfulness that introduces them into the present without memory that is the present of narrating speech." (Blanchot, 1981, p. 140)[119]

Order, Desire, and Kant

Neutrality as the object of metaphysical desire can never be established, touched, or known as an end in itself. It must endlessly defer to the desire of transactionalism, the next and future shiny, metal object where value is denominational. In Kantian philosophy, the thing-in-itself (German: *Ding an sich*) refers to the status of objects as they exist independently of representation and observation. The noumenon (or thing-in-itself) stands in contrast to the phenomenon, which represents how things appear to us. While we can study phenomena through our senses and reason, the noumenon remains elusive and inaccessible to direct observation. Immanuel Kant (1724-1804) argued that the empirical world—which encompasses all objects—is a complex of appearances. These appearances exist only within our representations. However, underlying these appearances is the thing-in-itself, which remains beyond our direct knowledge. We can only grasp its manifestations, not its true nature. Kant expressed this idea in his work, stating: "*And we indeed, rightly considering objects of sense as mere appearances, confess thereby that they are based upon a thing in itself, though we know not this thing as it is in itself, but only know its appearances, viz., the way in which our senses are affected by this unknown something*". [120]

The thing-in-itself represents the true nature of objects, beyond how they appear to us. It exists independently of our sensory experiences and mental constructs. Kant posited that while we can perceive and understand the world through our senses

(phenomena), there exists a deeper reality that remains unknowable —the noumenal realm. Essentially, the thing-in-itself is the underlying reality behind the appearances we encounter. The term “noumenon” is closely related to the thing-in-itself. It refers to the unknowable reality that lies beyond our sensory perceptions. Kant argued that human sensibility is receptive, allowing us to know the phenomenal world (appearances). However, the noumenal world remains beyond our grasp. While we recognize the existence of the noumenon, we cannot directly access or conceive it. Our cognitive faculties are limited to understanding phenomena. In his doctrine of transcendental idealism, Kant emphasized that the empirical world —the sum of all objects—is a complex of appearances. These appearances arise from our mental representations. Kant acknowledged that these appearances are grounded in a thing-in-itself, even though we lack direct knowledge of it. We only perceive its effects on our senses. Here’s how Kant expressed it:

> “And we indeed, rightly considering objects of sense as mere appearances, confess thereby that they are based upon a thing in itself, though we know not this thing as it is in itself, but only know its appearances, viz., the way in which our senses are affected by this unknown something.” — Prolegomena, § 32 1 121

Kant challenged the idea that our minds passively mirror external reality. In his work Critique of Pure Reason (1781), he argued that our perception of the world is not a direct reflection of how it truly exists. Instead, our minds construct a picture of reality based on sensory experiences. This groundbreaking idea implied that we cannot directly experience God through our senses; our knowledge of God is therefore a matter of faith rather than empirical evidence. 122 But sensory experiences are mediated by the will as practical reason: Kant believed that the will is not merely a blind force driven by sensations and desires. Instead, he saw it as

practical reason. This means that our will is guided by rational considerations, not just impulsive cravings. Kant's approach combines reason and desire in a unique way, shaping much of his moral philosophy.

Kant believed in individual autonomy and self-legislation. Kant famously emphasized autonomy—the idea that morality originates from the will's self-legislation. Morality's principles and motivating power don't depend on external sources; they emerge from within the will itself. This concept challenges the notion that desires alone dictate our actions. [123] Kant thought of desire as hedonism. Kant's view of desire differs from traditional notions. He considered desire as a natural empirical motive, implying determinism and being essentially beyond rational control. Moreover, desires are subjective, contingent states, making them an inadequate basis for moral motivation and universal rules. Kant also connected desires with pleasure, emphasizing their hedonistic nature. [124] Kant understands freedom as higher than desires. Kant's libertarian freedom involves being a slave to one's own desires. He didn't classify desires as rational fuel for moral judgments. Instead, he set boundaries for individual morals, emphasizing rationality over mere desire. Many of our founding fathers' assumptions built into our Constitution are based on Kant's idea that individuals would reason and act morally. [125]

F. H. Jacobi (1743-1819) was among the first to critique the concept of a thing-in-itself. He expressed the paradox that he couldn't enter Kant's system with this concept yet couldn't remain in it without it. G. E. Schulze (1761-1833) also challenged Kant's notion, arguing that things-in-themselves cannot cause appearances because causality applies only to objects of experience. If the thing-in-itself represents some mysterious essence behind appearances—a realm beyond our senses and reason, forever veiled in philosophical intrigue, how can it come into our experience, how could we sense it, how could it be a cause for sensation? Kant's transcendental idealism tells us noumena cannot be experienced, sensed, or even

known. Only phenomena can be experienced and known but only by perceptions, appearances, and concepts. However, even the word noumena from Greek *noein* means to conceive or apprehend. [126] Essentially, the thing-in-itself is the underlying reality that gives rise to the appearances we perceive.

Kant's thing-in-itself has an interesting relationship to physicist John Wheeler's (1911-2008) famous slogan "it from bit". According to Wheeler, everything in the physical world — whether it's a particle, a field of force, or even the fabric of spacetime itself — has an underlying source. This source is immaterial and deeply fundamental. It arises from the binary choices we make when observing the world: yes/no, true/false, on/off. These binary decisions are akin to the basic units of information, known as bits. Wheeler suggests that our experience of reality emerges from these binary decisions. When we observe an object, event, or phenomenon, we are essentially making a series of yes-no choices. These choices shape our perception of reality. In other words, reality is participatory — it arises from our interactions with the world. Information is theoretic origin meaning all things physical have their roots in information theory. The very existence and meaning of physical entities derive from the answers to binary questions. Whether it's a particle's behavior, the curvature of spacetime, or the properties of a field, it all traces back to information-based decisions. "It from Bit" symbolizes the idea that our reality is intricately woven from the fabric of information. Every aspect of the physical world ultimately arises from the binary dance of yes and no, making our universe a participatory and information-theoretic realm. Like Kant, there is no such thing as 'reality' only binary judgements which comes from perception. [127]

In both Kant and Wheeler, we must rely on the already understood ontological notion of 'it' as if that were a given. Even more so, the 'it' refers to and is the basis for perception and judgement and the concepts we form. However, for Kant the 'it' as the thing-in-*it*self could not come into phenomena but for Wheeler

the ‘it’ and phenomena are not sealed off from phenomena but intrinsic to phenomena. But even this, what we think as a very simple notion of ‘it’, was not always around from the beginning, the origin. The notion of ‘it’ as neutrality is not universal in history. Many ancient religions we call animistic did not even have a word for a ‘thing’ which was lifeless. The ancient animistic religions were animated by male gods and female goddesses. What we think of as inanimate objects did not exist in any form in many ancient cultures which saw all nature as energized in some mysterious way. Even Hesiod’s idea of chaos [χάος] was not neuter in the way we think of it.

> The ‘it’ comes ready-made by history and language. ‘It’ is ‘common sense’. If we want to think philosophically we must understand that these read-made notions were not available to Hesiod. If we simply take over our contemporaneous idea of the ‘it’ when we read Hesiod we do what scholars of ancient Greek literature (called philologists) call anachronistic (belonging to a period other than that being portrayed). In order to understand Hesiod we must let χάος [chaos] speak to us in proximity to what we can glean from the texts we have and what scholars tell us of their context. We must relieve ourselves of the assumption that chaos was an ‘it’, devoid of life or gender. While the myths of the ancient Greeks indicate a kind of animate vitalization of phusis as we see in the pantheon of gods, the notion of ‘neuter’ in ancient Greek was ‘neither one nor the other’ as in ‘not masculine or feminine’.[128] The neuter was the ‘not’ in ancient Greek of gender. The negative does not specify a positive term as modern usage does of the ‘it’ (i.e., substance, inanimate objects, not alive, thing, etc.). Furthermore, as we will see later in this text χάος in Ancient Greek can be used in different ways including the feminine gender.[129]

Individual autonomy and freedom as rational may be a moral imperative for Kant. However, these days individual autonomy has found another way towards freedom which is not based on rational imperative. Our modern notion of neutrality as simply 'it' has no moral imperative. The universal and absolute of classicism has been transformed into inanimate and anonymous 'matter', stuff, a thing which only has use value for us as Heidegger might tell us – standing reserve. In modernism this has found its way into individual autonomy and freedom. The metaphysical assumption of neutrality has congealed as 'common sense'. This brings with it another meaning to the idea of freedom. Freedom defined by neutrality cannot contest me. The 'it' we face is transformed into 'my freedom' which must always come before any consideration of the other. Freedom has become the monad of individual autonomy. Freedom is the sacrosanct right to unrestrained echoing of oneself back to oneself, what is mine, what I want, what I do not have, and acquisition is ethic-based on transaction. In this sense freedom has found its way to another concept in Kant – the thing-in-itself. Individual autonomy as right and privilege, as monadic echo, which has no restrictions is impenetrable with no reference to externality. The entire history of modernism, the thinking thing, has overtaken Kant's moral imperative not to treat others as a means to an end but as a noumenal and ethical end in themselves, as an other which exceeds the thinking thing that has become recursively internalized, impenetrable to externality.

On Hegel

At the end of the 18th century, we saw a similarity to exformation with Kant's notion of *a priori* in that Kant did not attribute a cause to analytic judgement based on *a priori* categories of understanding. Kant did not attribute causality to analytic judgments. He recognized that *a priori* categories lie outside the concept of something happening, something in motion or change. Therefore,

cause and effect cannot be understood as a synthetic judgment; instead, cause and effect itself arises from an *a priori* category of understanding meaning cause and effect is an analytic judgement. In the mid-19th century Freud employed the notion of *a priori* in terms of the unconscious. Freud used the analogy of the common child's toy, the mystic writing pad, to illustrate how when the plastic sheet is lifted up and the drawing disappears, there is still an imprint on the pad which he thought as the unconscious. The unconscious was still there apart from the agent of consciousness and worked behind the scenes of consciousness to influence behavior. The unconscious had a hazy relation with cause and effect in terms of consciousness. The unconscious was not a temporal event but a-temporally held events, unassembled information (exformation) which might be expressed in tensions between the id and the superego. He called these tensions the ego.

In the 19th century, the German idealist Hegel fundamentally changed Aristotle's and Kant's indeterminacy with regard to origin and categories of understanding. Hegel believed he was able to accurately account for their uncertainties through dialectic. Hegel found an absolute knowing in dialectic in which knowing is immanent and can only be the condition for truth. At the end of Hegel's "*Phenomenology of Spirit"* he concludes that we must overcome the separation of knowing and truth. He reinterpreted and rearticulated classical philosophy through Aristotle and Kant in a way that is still highly researched today. Hegel's methodology is dialectic which is a system of logic which was to give a full and accurate account of all phenomena from human 'being' to time and space. Let's go through an example of what he wrote at the beginning of probably his greatest work, *Science of Logic*. In the beginning movements of his famous work "The Science of Logic", he writes:

> Being is being, and nothing is nothing, only as held distinct from each other; in their truth, however, in their unity, they

> have vanished as such determinations and are now something else. Being and nothing are the same and, precisely because they are the same, they no longer are being and nothing but possess a different determination; in becoming they were coming-to-be and ceasing-to-be; in existence, which is another determinate unity, they are again moments but differently determined. This unity now remains their base from which they no longer surface in the abstract meaning of being and nothing. 130

The genius of Hegel was to convert Aristotelian potentiality from non-existent to what he terms 'nothing' and Aristotle's actuality to 'Being' at the start in his premiere work entitled "The Science of Logic". In so doing, Becoming originates from Being and nothingness. In juxtaposing nothingness and Being, "*held distinct from each other*", he finds an inner unity in that they are "*the same*". They are both moments of the same "*in becoming they were coming-to-be and ceasing-to-be; in existence, which is another determinate unity, they are again moments but differently determined*" into the transformation of becoming. Hegel converts actuality and potentiality, existence and non-existence to a unity as "the same" which then is differentiated in the transformation of becoming. In analogous terms of what has been discussed for quantum mechanics, becoming has now obviated spooky exformation as a-causal, atemporal, a-spatial, etc. and in its place transformed it into sheer becoming with no excess, no 'ex'. Hegelians would say the excess to Being and nothing is subsumed, taken up, entirely into becoming which maintains its predecessors but also unites and exceeds them. In effect, becoming concretizes the oppositional abstraction of Being and nothing.

Much later in the dialectical progression of Hegel's work, logic must find its completion in Concept or the Idea. But in order for Concept to achieve this, Concept must comprehend itself. This is self-comprehension. However, in order to achieve self-

comprehension, Concept must also alienate itself. In order for the Idea to achieve self-awareness, to realize itself, it must experience alienation—a distancing from its own essence as self-externality. Hegel compares the dialectic of self-consciousness (not yet self-realized) with the famous dialectic of the master and slave relationship. Just as the slave overcomes alienation by recognizing their dependence on the lord, consciousness achieves absolute knowing by transcending self-alienation. Concept's dual requirements of self-awareness and alienation requires that it emerge as a 'here' and 'now', as alone and eternal which can also be abstracted as a point. But as the 'here' and 'now' and solitude to be what it is, it must have a 'before' and after'. It must have others, a collectivity, a state. Therefore, the abstract point of solitude must emerge as time, as temporality. In Hegel's "Logic," being itself is temporality. The past is timeless and involved in the actualization of the present. The present is comprehended through *Gewordensein* (becoming), which expresses inherent possibilities of actuality. Hegel's philosophy embraces plasticity, acknowledges the dynamic nature of time, and allows for future transformations. Let's look at how Hegel tells us spacetime emerges. [131]

In Hegel's "Philosophy of Nature", he starts with the most general abstract notion of nature. Hegel writes,

> The first or immediate determination of nature is the abstract generality of its self-externality,-its unmediated indifference, space. It is the wholly ideal juxtaposition, because it is being outside of itself and absolutely continuous, because this being apart from itself is still entirely abstract, and has no specific difference within itself… [132]

As abstract and general nature comes before us self-externality. It is entirely abstract externality and is undifferentiated, "*no specific difference within itself*".

> Space has, as the concept in general (and more determinate than an indifferent self-externality) its differences within it: (a) in its indifference these are immediately the three dimensions, which are merely diverse and quite indeterminate… 133

But when we look more concretely at space, we see three dimensions. But these three dimensions are themselves abstract and indeterminate.

> But the difference of space is essentially a determinate, qualitative difference. As such it is (a) first, the negation of space itself because this is immediate and undifferentiated self-externality, the point. (b) The negation as negation, however, is itself spatial, and the relation of the point to space is the line, the first otherness of the point. (c) The truth of the otherness is, however, the negation of the negation. The line, therefore, passes over into the plane, which on the one hand is a determinacy opposed to line and point, and thus is plane in general, but on the other hand is the suspended negation of space, and thus the re-establishment of spatial totality, which, however, now contains the negative moment within itself an enclosing surface, which splits off an individual, whole space. 134

But looking at space more concretely we see that the quality of space is first a point, one-dimensional. But if we negate a single point, we get multiple points as a line, two-dimensional. And if we negate the line, we get multiple lines which pass over into a plane, three-dimensional space. If we negate three-dimensional space itself, we get the totality of space. But negating the totality of space as individual space we see a geometric enclosing like a sphere perhaps.

That the line does not consist of points, nor the plane of lines, follows from their concepts, for the line is the point existing outside of itself relating itself to space, and suspending itself and the plane is just as much the suspended line existing outside of itself.-Here the point is represented as the first and positive entity, and taken as the starting point. The converse, though, is also true: in as far as space is positive, the plane is the first negation and the line is the second, which, however, is in its truth the negation relating self to self the point. The necessity of the transition is the same.-

The other configurations of space considered by geometry are further qualitative limitations of a spatial abstraction, of the plane, or of a limited spatial whole. Here there occur a few necessary moments, for example, that the triangle is the first rectilinear figure, that all other figures must, to be determined, be reduced to it or to the square, and so on.-The principle of these figures is the identity of the understanding, which determines the figurations as regular, and in this way grounds the relationships and sets them in place, which it now becomes the purpose of science to know…

Negativity, which as point relates itself to space and in space develops its determinations as line and plane, is, however, in the sphere of self-externality equally for itself and appearing indifferent to the motionless coexistence of space. Negativity, thus posited for itself is time… 135

In the quote above Hegel goes on to exhibit how all this negating of the point, the line, the plane culminating in the sphere must also be negated as the self-externality of the sphere is static and motionless. So, negating the static and motionless sphere gives rise to temporality in order to make space dynamic and changing.

Time, as the negative unity of being outside of itself, is just

as thoroughly abstract, ideal being: being which, since it is, is not, and since it is not, is. 136

But if time is negated, we get being which is and is not. This is a binary duality in which being is evoked.

Time, like space, is a pure form of sensuousness, or intuition; but, as with space, the difference between objectivity and a contrastingly subjective consciousness does not matter to time. If these determinations are applied to space and time, then space is abstract objectivity, whereas time is abstract subjectivity. Time is the same principle as the I = I of pure self-consciousness; but the same principle or the simple concept still in its entire externality, intuited mere becoming, pure being in itself as sheer coming out of itself. Time is just as continuous as space, for it is abstract negativity relating itself to itself and in this abstraction there is as yet no real difference. 137

Now Hegel tells us that both time and space negated as being is the pure form of sensuous which he also calls intuition. But objectivity and its negation of subjectivity or consciousness does not matter to time. But there is a relativity at work in that if we apply negations to space and time then space is objective, and time is abstract subjectivity. This is where identity is abstractly established as I = I. This is pure self-consciousness. But for self-consciousness to come out of itself, negate itself, it abstractly intuits becoming.

In time, it is said, everything arises and passes away, or rather, there appears precisely the abstraction of arising and falling away. If abstractions are made from everything, namely, from the fullness of time just as much as from the fullness of space, then there remains both empty time and empty space left over; that is, there

are then posited these abstractions of exteriority.-But time itself is this becoming, this existing abstraction, the Chronos who gives birth to everything and destroys his offspring.-That which is real, however, is just as identical to as distinct from time. Everything is transitory that is temporal, that is, exists only in time or, like the concept, is not in itself pure negativity. To be sure, this **negativity is in everything as its immanent, universal essence**, but the temporal is not adequate to this essence, and **therefore relates to this negativity in terms of its power**. Time itself is eternal, for it is neither just any time, nor the moment now, but time as time is its concept. The concept, however, in its identity with itself I= 1, is in and for itself absolute negativity and freedom. Time, is not, therefore, the power of the concept, nor is the concept in time and temporal; on the contrary, the concept is the power of time, which is only this negativity as externality.-The natural is therefore subordinate to time, insofar as it is finite; that which is true, by contrast, the idea, the spirit, is eternal. Thus the concept of eternity must not be grasped as if it were suspended time, or in any case not in the sense that eternity would come after time, for this would turn eternity into the future, in other words into a moment of time. And the concept of eternity must also not be understood in the sense of a negation of time, so that it would be merely an abstraction of time. For time in its concept is, like the concept itself generally, eternal, and therefore also absolute presence. 138

But pure abstract self-consciousness is powerless. When self-consciousness is as pure abstraction, it negates as powerless. But abstract powerlessness must give way to power - power as origin I = 1, a start. In turn, when self-consciousness as the power of origin is negated, we get spirit as eternal. But Hegel warns us not to

understand the negation of the concept of eternity as a moment of time. That does not proceed from more abstract to more concrete. Therefore, eternity, absolute spirit, is absolute presence. This is the progression of 'logic' for Hegel and is still actively researched and published even today in Hegelian scholarship.

You may have noticed that Hegel leaves out Einstein's relativity and no mention of quantum physics' negations as well. Of course, that is because Hegel's "Philosophy of Nature" was published in 1817. Einstein and quantum mechanics did not come around until the start of the 1900's. It should also be evident that a certain classical interpretation of time and space and self-consciousness has the archaic ring of classical science of Hegel's day. It would be interesting if some of the current Hegelian scholars would take a crack at that, but it seems to me that delving too deeply into such matters might necessitate a postmodern 're-reading' of Hegel. Perhaps we might call this the anti-Hegel or the negation of Hegelianism.

In Hegel's "Philosophy of Nature", he further delves into the essence of motion. According to him, motion embodies the immediate unity of space and time. This unity implies that time now has real existence within a space that is truly differentiated by it. In other words, time and space become actual in motion. This convergence signifies that what time and space are in Concept aligns with what they are in appearance. Hegel views time as introducing diversity (or negation) into space, thereby actualizing it. Rather than perceiving isolated points or instants, we experience "here-nows"—a continuous temporal flow. For Hegel, temporality is marked by a hierarchical sequence of ever enjoining dialectical steps ultimately culminating as absolute Concept. As absolute Concept. But for Concept to truly be absolute it must concretize itself, 'not' itself, as space and then time and then becoming and so on until yet again when we once again arrive at absolute Concept for the first time. Pardon my sarcastic desecration of Hegel's genius. I freely admit that I am not worthy! Oh, did I mention that Hegel is

a distant relative of mine, so I guess this is a bit of a family feud (; -).

Catherine Malabou, in her work “The Future of Hegel: Plasticity, Temporality and Dialectic,” challenges the prevailing notion that Hegel’s philosophy is solely oriented toward the past and lacks a future perspective. Malabou argues that Hegel’s concept of “plasticity” plays a crucial role. Plasticity refers to the capacity to receive and produce form, allowing for transformation and adaptability. Hegel’s view of humanity, divinity, and philosophy is more flexible than often portrayed. He conceives of these aspects as inherently amenable to future changes. In his discussion of anthropology, Hegel emphasizes habit as liberating the human subject from the constraints of nature. Human beings possess “plastic individuality”, implying the ability to develop and differentiate over time. Hegel’s concept of plasticity plays a pivotal role. Plasticity refers to the capacity for transformation and adaptability. When we engage with Hegelian concepts, we participate in a dialectical process. Rather than demonstrating propositions, we allow concepts to unfold and reveal their implications. The dialectical motion is meant to allow us to see how time and space intertwined, affecting our understanding of existence and change.

Hegel considers time as the first mediation of outsideness. It negates space and forever remains related to it. Unlike isolated points or instants, we experience time as a continuous flow—a series of “here-nows”. Time’s role is not merely chronological; it mediates our perception of the external world. In Hegel’s Logic, being itself is temporality. The past, timeless yet involved in actualization, shapes the present. The present unfolds through *Gewordensein* (becoming), revealing inherent possibilities of actuality. Hegel believes his Concept transcends mere abstraction; it becomes a dynamic interplay between time and space. 139

This process of abstracting and then concretizing is a technique which is typical of Hegel’s entire circular enterprise from Being and

nothingness through Concept through solitude overlapping here and now/point to sociality overlapping multiple 'heres' and 'nows' in which a spatial point becomes temporal points arising back again to Being and nothingness. For Hegel, concretizing does not undo the tension of abstraction but completes what is lacking in abstraction. It seems to me that each step along the way might also be thought of as relative uncertainties, abstractions, which get taken up into relative certainties, concretizing, and then evolving through an entire process of such movements which, in an almost Nietzschean eternal recurrence mode, finds a circularity. In any case, these abstract to concrete progressions seem to me to have at least a momentary similarity to classical certainty. In a kind of circular ascending and descending fashion classical certainties in the history of science seem to be eclipsed with paradigm shifts which eventually expand and perhaps give expanded context to prior paradigms. If so, both Hegelian dialectics and knowledge itself might find a kind of cyclical musical harmony and discophony which have an ascendant progressive quality. This is mere speculation, could this kind of move have at least an analogous similarity with the whole classical question of how the anarchical and chaotic get transformed wholly and completely concretizing as origin. Could origin then be abstract and in turn concretized as cause and effect?

In any case, exformation is not willing to play in Hegel's Concept. In quantum physics exformation is severely different than what Hegel and our history of knowledge leads us to believe. What 'is' has a shady association with what is not. "*Coming-to-be*" and "*ceasing-to-be*" are not separate and determinate moments which rise into becoming. Neither is "c*oming-to-be*" and "*ceasing-to-be*" the same. Exformation has a hazy middle, an uncertainty, an indeterminacy which can find a limited classical amount of predictability in the branching of probability associated in some hazy fashion with the observer effect. So, the question to be or not to be has a hazy middle. Hegel's notion of becoming obfuscates the

current findings of physics and appears to yet again be trapped in a certain philosophical tradition of the classical world.

In Hegelian dialecticism we see a succession of logical oppositions which lead to transformations that unify the oppositions while maintaining their difference. By dialectic, I mean a positive concept followed by its negation, the negative of that concept, followed by the unification of both concepts through a transformative concept. For Hegel, there is no way to separate knowing and truth. Truth must always be in the context of knowing. For Hegel, as Leibniz, all predicates resided in the subject but for Hegel the subject eventually rises as absolute Concept not the monad. However, exformation as the sense of Hesiod's chaotic, yawning gap cannot simply be the transformation of dialectic. It cannot follow classical notions and cycles of absolute and completeness. It exceeds logical determinations in its necessary indeterminacy. Virtual particles in a Hegelian sense cannot be transformed, lifting up, sublimated (in German *aufhebung)* from particles into Concept (e.g., as mathematics). There is an incomplete excess in quantum physics which knows nothing of rising into Concept.

The mathematics of the wave function is highly incomplete. Hegel's *aufhebung* is considered as complete with regard to fully transforming and accounting for both positive and negative, concrete and abstract, conceptual components. Once a 'leaky', uncertain, spooky middle is acknowledged the entire Hegelian conceptual frame is put into question. Only language in its classical narratives would give us the illusory mirage of completeness (Hegel) or mathematics mirrored in the tautology of identity (Leibniz). 'Knowing' has an uncertainty about it which cannot be fully accounted for or 'taken up'. In my estimation Hegel's dialectic is rooted in a certain custom of language which obliviates the 'ex' in exformation. There is a persuasion in naming and logic with regard to identity that gets taken up into our lived life which gives us a false sense of assurance, even to the point of the extremism of

violence and arrogance.[140] This is not to suggest that 'knowing' has no 'truth'. In the analogous way that classic physics is a subset, a limiting case, of quantum mechanics; knowing is a subset and limited case of an 'ex', an externality, which defies absolute determinacy. Additionally, "knowing' can never be detached from a language, a custom, and a history as it can never fully detach itself from hermeneutics. With regard to the wave function, the practical, applied findings of mathematics give us a certain amount of predictability. One practical effect of predictability is to enable us to manufacture faster, smaller, less power consuming integrated circuits. However, there is nothing in the wave function that would indicate finality. The actual details of the wave function in current science are highly contrary to any sense of completeness, classic certainty, and any equivocations which find agreement with, on the one hand, absolute certainty, determinacy, and on the other hand, truth and knowing.

Hegel's Kant Fix

Kant's thing-in-itself is built on a classical modernist idea that knowledge is internalized to the individual. Any other is a thing which we can know nothing about. This has become the 'it' of the historic abstraction of reality as neuter, as objects, of which we have no direct relation with. In the 19th century G.W. Hegel believed he had unraveled Kant's thing-in-itself.

> However, Kant's solution to Hume's skepticism led to a skeptical conclusion of its own that Hegel rejected. While the intersubjectively shared structure of our reason might allow us to have knowledge of the world from our perspective, so to speak, we cannot get outside of our mental, rational structures to see what the world might be like in itself. As Kant had to admit, according to his theory, there is still a world in itself or "Thing-in-itself" (*Ding an sich*) about which

> we can know nothing. Hegel rejected Kant's skeptical conclusion that we can know nothing about the world- or Thing-in-itself, and he intended his own philosophy to be a response to this view.[141]

Hegel, in agreement with Kant, proposed that necessary truth must be imposed by the mind, but he rejected Kant's concept of the "thing-in-itself" as unknowable. According to Hegel, all that exists *is mental* and is consequently accessible to individual consciousness. Kant's notion of the "thing-in-itself" (German: *Ding an sich*) refers to the status of objects as they are, independent of representation and observation. Kant argued that the empirical world—the sum of all objects—is a complex of appearances, whose existence and connection occur only in our representations. The thing-in-itself remains elusive, as we can only know its appearances, not its true nature. Hegel, however, took a different stance. Hegel radicalized Kant's transcendental idealism into absolute idealism, asserting that the concept of things-in-themselves is a contradiction. For Hegel, a thing must be an object of our consciousness to exist at all. He critiqued Kant's incomplete process of abstraction and the absolute distinction between subject and object. While Kant grappled with the unknowable "thing-in-itself," Hegel emphasized the centrality of consciousness and rejected the existence of such hidden entities. The fix for Hegel was to jettison the metaphysical abstraction of neutrality and objectivity altogether. However, for Hegel, this then is ultimately lifted up from subject/object absolute Concept. In this way, Hegel has more of an affinity to Wheeler in that there is no exteriority to concept. The thing-in-itself arises wholly into concept without any residue. For Hegel noumena is phenomena is concept. Hegel was taken with Leibniz and his idea that all predicates reside in the subjects. However, for Hegel there was a difference. [142] The following will be a brief sketch of Hegel's overall strategy for his two major works, "Phenomenology of Spirit" (1807) and the "Science of Logic" (1812-1818). These works are intensely difficult

to understand. Incredibly, there are still many active schools of philosophy which are still researching and publishing Hegel's works. I think this should be read with the backdrop of previous discussions on quantum physics.

Hegel's Start with Subjective Spirit: Consciousness to Self-Consciousness to the State

> Hegel as a philosopher who had introduced this historically reflective dimension into philosophy (and set it on the characteristically romantic path which has predominated in modern continental philosophy) but who had unfortunately still remained bogged down in the remnants of the Platonistic idea of the search for ahistorical truths (Rorty 1982). Those adopting such an approach to Hegel tend to have in mind the (relatively) young author of the Phenomenology of Spirit and have tended to dismiss as "metaphysical" later and more systematic works like the Science of Logic. 143

Leibniz's focus on predicates residing within subjects aligns with his intricate metaphysical system of monads. Hegel, on the other hand, emphasized the subject's emergence within historical and communal contexts. While Leibniz's theory emphasizes the relationship between predicates and individual monads, Hegel's perspective centers on the subject's connection to the human community in his "Phenomenology of Spirit". In "The Phenomenology of Spirit", Hegel embarks on a profound exploration of the development of human knowledge. Notwithstanding, all of this eventually, through the dialectic of his "Science of Logic," ends up in Concept. 144 What binds all this together must have something to do with the question of consciousness.

> Hegel describes spirit as sunk in nature, and treats consciousness as largely limited to what now might be described as sentient or phenomenal consciousness alone—the feeling soul. Consciousness in the sense of the modern subject–object opposition only makes its appearance in the following second section, Phenomenology of Spirit, which, reprising key moments from the earlier book of that name, raises a problem for how we are to understand the relation of phenomenology and systematic philosophy: is it a path to it or part of it? 145

This is where Hegel starts his investigation in his early work the "Phenomenology of Spirit". Hegel starts with unhappy consciousness. Unhappy consciousness has three stages: external beyond, changing individual, and achieved reconciliation. At the outset, consciousness grapples with sensory inputs, attempting to grasp objects in the external world. This initial stage represents a fundamental encounter with the external phenomenal realm. As consciousness evolves, it moves beyond mere sensory perception. It engages in more sophisticated ways of relating to the external world. Here, the individual undergoes transformations, adapting and growing. Finally, Hegel envisions a state where consciousness attains reconciliation. This reconciliation occurs through self-awareness, mutual recognition, and the interplay of self-consciousness with other self-consciousnesses. "Phenomenology of Spirit" grapples with the journey from sensory experience to self-consciousness, weaving together metaphysics, epistemology, ethics, and political philosophy. 146

In the "Phenomenology of Spirit" Hegel grappled with the concept of "Concept" and where it encountered challenges. Hegel described the book as an "exposition of the coming to be of knowledge." He meticulously traced the journey of spirit through various stages, from sense perception to absolute knowing. The concept of Concept emerges as spirit evolves, but it is not a static

entity. Instead, it undergoes a necessary process of self-origination and dissolution. This dynamic movement is central to Hegel's dialectical method. Hegel's understanding of how concepts come into being implies a certain instability or insecurity in knowledge. Unlike Kant, who emphasized the mediating role of concepts, Hegel recognized that concepts themselves are subject to change and transformation. This instability arises from the inherent tension between different shapes of spirit as it progresses toward pure knowledge. Hegel's exploration reveals that knowledge is not a fixed endpoint but an ongoing process. In the Preface to the Phenomenology, Hegel rejected the notion of absolute knowledge based on immediate intuition or feeling. Such an approach, he argued, would dissolve the rich differentiation and determination of empirical content into a vague obscurity. Instead, Hegel sought a more rigorous path—one that grappled with contradictions, engaged in dialectical movement, and ultimately arrived at a more coherent system of knowledge. When multiple self-consciouses attain the state subjectivity has attained its highest goal. But how does the state arise to objectivity, to universals? 147

Hegel's Transition to Objective Spirit: Concept

> In contrast, the British Hegelian movement at the end of the nineteenth century tended to ignore the Phenomenology and the more historicist dimensions of his thought, and found in Hegel a systematic metaphysician whose Logic provided the basis for a definitive philosophical ontology. This latter traditional metaphysical view of Hegel dominated Hegel reception for most of the twentieth century, but from the 1980s came to be challenged by scholars who offered an alternative non-metaphysical, post-Kantian view. By "non-metaphysical" these thinkers had in mind metaphysics in the sense that Kant had been critical of, a point sometimes missed by critics. But in turn, this post-Kantian reading has

> been challenged by a revised metaphysical view, critical of the purported over-assimilation of Hegel to Kant by the post-Kantians. In the revised metaphysical view, appeal is often made to Aristotelian or Spinozist conceptual realist features of Hegel's thought, as well as to features of recent analytic metaphysics. 148

Hegel does not want to end at Kant's thing-in-itself, *a priori* categories of knowledge, and a moral categorical imperative. Hegel wants to understand how subjectivity and community can arise into objectivity, the universal, and eventually the absolute as pure Concept.

> Hegel, however, thought that philosophy had to unify theoretical and practical knowledge, and so the Phenomenology has further to go. Again, this is seen differently by traditionalists and revisionists. For traditionalists, Chapters 7, Religion and 8, Absolute Knowing, testify to Hegel's disregard for Kant's critical limitation of theoretical knowledge to empirical experience. Revisionists, on the other hand, tend to see Hegel as furthering the Kantian critique into the very coherence of a conception of an in-itself reality that is beyond the limits of our theoretical (but not practical) cognition. Rather than understand absolute knowing as the achievement of some ultimate God's-eye view of everything, the philosophical analogue to the connection with God sought in religion, post-Kantian revisionists see it as the accession to a mode of self-critical thought that has finally abandoned all non-questionable mythical givens, and which will only countenance reason-giving argument as justification. However we understand this, absolute knowing is the standpoint to which Hegel has hoped to bring the reader in this complex work. This is the standpoint of science, the

> standpoint from which philosophy proper commences, and it commences in Hegel's next book, the Science of Logic. 149

How does self-conscious and community end subjective spirit and find a beginning in objective spirit? Hegel starts out the "Science of Logic" with Being and Nothingness. He believes these are dialectical opposites which both depend on each other to mean something. By themselves they mean are contradictory and mean nothing. However, the tension between the two must necessarily lead to becoming. This short synopsis demonstrates Hegel's method throughout the "Logic".

> Reading into the first chapter of Book 1, Being, it is quickly seen that the transitions of the Logic broadly repeat those of the first chapters of the Phenomenology, now, however, as between the categories themselves rather than between conceptions of the respective objects of conscious experience. Thus, being is the thought determination with which the work commences because it at first seems to be the most immediate, fundamental determination that characterises any possible thought content at all. (In contrast, being in the Phenomenology's Sense-certainty chapter was described as the known truth of the purported immediate sensory given—the category that it was discovered to instantiate.) Whatever thought is about, that topic must in some sense exist. Like those purported simple sensory givens with which the Phenomenology starts, the category being looks to have no internal structure or constituents, but again in a parallel to the Phenomenology, it is the effort of thought to make this category explicit that both undermines it and brings about new ones. Being seems to be both immediate and simple, but it will show itself to be, in fact, only something in opposition to something else, nothing. The point seems to be that while the categories being and nothing seem both absolutely

> distinct and opposed, on reflection (and following Leibniz's principle of the identity of indiscernibles) they appear identical as no criterion can be invoked which differentiates them. The only way out of this paradox is to posit a third category within which they can coexist as negated (Aufgehoben) moments. This category is becoming, which saves thinking from paralysis because it accommodates both concepts. Becoming contains being and nothing in the sense that when something becomes it passes, as it were, from nothingness to being. But these contents cannot be understood apart from their contributions to the overarching category: this is what it is to be negated (aufgehoben) within the new category.
>
> In general this is how the Logic proceeds: seeking its most basic and universal determination, thought posits a category to be reflected upon, finds then that this collapses due to a contradiction generated, like that generated by the category being, and so then seeks a further category with which to make retrospective sense of those contradictory categories. However, in turn the new category will generate some further contradictory negation and again the demand will arise for a further concept that can reconcile these opposed concepts by incorporating them as moments. 150

At this point Becoming embarks upon a quest for answers. Becoming searches for reasons why it is something and not nothing. This is the journey towards truth. This journey is characterized by something we now might call 'language games'. Interestingly, I find this also in Wheeler's 'it from bit' of yes and no judgements. In Hegel's "Science of Logic", the quest for truth takes on a profound dimension. While truth is commonly understood as the agreement of thought with the object, Hegel delves deeper into its philosophical essence. According to him, philosophical truth is the agreement of a content with itself or of an object with its concept.

This concept transcends mere correspondence and ventures into the realm of self-consistency. Hegel's "Science of Logic" aims to overcome a flaw he perceives in other systems of logic. These systems often assume a complete separation between the content of cognition (the world of objects, considered independent of thought) and the form of cognition (the thoughts about these objects, which are pliable and dependent on their conformity to the world of objects). Hegel seeks to bridge this gap, emphasizing that reality is shaped by thought and is, in a strong sense, identical to thought. In this pursuit, Hegel explores the dynamic process by which consciousness assimilates objects into mental concepts. His journey traces the movement from basic categories to more complex ones, revealing the intricate interplay between thought and reality. Therefore, the quest for truth in Hegel's "Science of Logic" is not merely about universality; it encompasses the very fabric of thought, weaving together content, form, and self-consistency in a philosophical tapestry. 151

> If the concrete object of a de re judgment is effectively what had been under consideration in Chapter 2, Perception, in the Phenomenology (the thing with properties), we now might envisage where Hegel's thought is headed in these sections of the subjective logic. In the Phenomenology it turned out that the capacity for a subject to entertain objects of consciousness such as perceptual ones was that such a subject was capable of self-consciousness. It then turned out that to be capable of self-consciousness the subject had to exist in a world with other embodied subjects whose intentions it could recognize. It is here that we might pick up Robert Brandom's suggestion, following Sellars, that we should think of the existence of inferential processes or processes of reasoning as presupposing participation within social communicative interactions in which the making of an assertion is considered as a move in a language-game of the

> "giving and asking for reasons". In short, we may think of Hegel's syllogism of necessity, which constitutes the ground or "truth" of the earlier formal conception of syllogisms, as a type of inter-subjective practice embodying thought—a type of syllogising practice that is by necessity inter-subjective and recognitive. Formally considered we might think of this syllogism as the logical schematization of the most developed form of recognition in which thinkers acknowledge others as free thinkers. 152

Hegel believes he lays out a firm case for subjective and objective spirit. Subjective spirit deals with the problem of 'mind'. In contrast remember the previous discussion in the section "Quantum Mind". I will come back to this soon.

3.2.2 Philosophy of Subjective and Objective Spirit

In the Encyclopaedia, Philosophy of Nature is followed by Philosophy of Spirit (Geist). Hegel's usual triadic pattern when applied here results in sections devoted to the philosophies of subjective spirit, objective spirit, and absolute spirit. Philosophy of subjective spirit constitutes what is closest in Hegel's philosophy to a philosophy of mind in the contemporary sense, while the philosophy of objective spirit concerns those objective patterns of social interaction and the cultural institutions within which spirit is objectified in patterns of human life we have seen at work in Phenomenology of Spirit. Within subjective spirit, we may anticipate that the first division, Anthropology, will follow on from topics with which Philosophy of Nature ends—the animal organism—and so it does. Thus here Hegel is concerned with what he terms "Seele", "soul"—which seems to translate more the ancient Greek term, "psyche"—and hence the mind-body relation:

> If soul and body are absolutely opposed to one another as

is maintained by the abstractive intellectual consciousness,

Hegel comments,

> then there is no possibility of any community between them. The community was, however, recognized by ancient metaphysics as an undeniable fact. [153]

Finally, Hegel believes he has made the case for absolute spirit.

> Phenomenology from shapes of consciousness to shapes of spirit. The internal Phenomenology of Spirit seems to play an important role in setting up this transition from Psychology to Objective Spirit (Williams 2007), but it might also be seen as crucial in relating the more cognitive dimensions of Psychology back to the theme of embodiment prominent in Anthropology (Nuzzo 2013a).Thus any naturalistic analysis is ultimately surpassed by a social and historical one, which itself cannot be understood as anti-naturalistic.
>
> The philosophy of subjective spirit passes over into that of objective spirit, which concerns the objective patterns of social interaction and the cultural institutions within which spirit is objectified. The book entitled Elements of the Philosophy of Right, published in 1821 as a textbook to accompany Hegel's lectures at the University of Berlin, essentially corresponds to a more developed version of the philosophy of objective spirit and will be considered here. [154]

But this is not your father's God. Absolute spirit cannot be what it is without being what it isn't. Absolute carries the requirement of everything with no excess to itself in order to qualify as absolute. So, absolute spirit must start all over again by once again for the first time forgetting itself, differentiating itself as a simple point, this is space, but point must differentiate itself so it must become time and from there we eventually go back through the entire cycle.

> Hegel concludes the lectures with the claim that he has, tried to exhibit their (this series of spiritual configurations) necessary procession out of one another, so that each philosophy necessarily presupposes the one preceding it. Our standpoint is the cognition of spirit, the knowledge of the idea as spirit, as absolute spirit, which as absolute opposes itself to another spirit, to the finite spirit. To recognize that absolute spirit can be for it is this finite spirit's principle and vocation. (LHP 1825–6, III: 212) [155]

But now, in current physics the notion of 'it' has taken a new turn. Instead of Kant's 'thing-in-itself' conveying no information about noumena or Hegel's pure Concept, quantum computing finds no metaphysical 'thing' or Concept. Instead, it has a spooky way to find exformation in the wave function's branching of the observer effect of quantum branching. Quantum computing tells us that vast sources of quantum information can be utilized in the form of qubits. These vast sources can be thought of as reducing the vastness of what history calls 'it' into orders of magnitudes more powerful practical applications. However, this usefulness does not infer our conventional notions of practicality which subsists in some underlying 'reality'. Neither does it exist as some metaphysical notion of psychic energy. Neither does it lapse into some purely subjective substratum. This technology relies on non-spatial, non-temporal phenomena to perform calculations very differently from today's digital technologies. Quantum computing has vastly improved results for highly complicated problems in many areas of scientific research, encryption, communications, and memory storage. However, the fact still remains that all this relies on quantum entanglement which has no particular persisting state except in our utilization of it.

In some ways Hegel's circularity of object spirit and its absoluteness inclusive of what it is not might remind us of Nietzsche's eternal recurrence of the same. But for Hegel the same

never reoccurs as this would require absolute spirit not forgetting itself altogether. In other ways, this could sound a bit like LaPlace's demon as the universal (or absolute) wave function. However, the wave function has no unifying Concept, no ultimate completion beyond chaos, complexity, emergence and novelty in contradistinction to a unifying universal[156] wave function. Even the phrase universal[157] wave function is misleading as universal must be essentially thought from classical branching not from quantum physics. Hegel ends and begins again anew in absolute spirit. Quantum physics has no beginning or ending, no origin or *telos,* other than branchings from the observer effect. Quantum physics does not consolidate into classical terms. It remains from the intuitions of the ancients as chaos and from Levinas as radical alterity. Absolute spirit has no necessary appeal to ethics. Ethics is contingent on the development of spirit. Ethics is a higher principle, evolution of spirit, but at the expense of an alterity which can be subsumed into origin, of belonging and finding its home along the way towards absolute spirit. For Levinas, radical alterity of the other remains without the option for an echo in objective spirit.

The 20th Century

Certainly, we can no longer relate and understand each other as sense machines. We can no longer be cogs in the machinery of history. Who we are, who I am, who my neighbor is has been brought before us as radical alterities. Throughout this major section of the book, I want to explore deeply some of the varying implications of how we understand ourselves and 'me', who we are with each other. In my opinion, at the end of all epochs we must not merely bracket, époque, our collective and individual histories but allow them to find their way back to the oblivion from which they came in order to let severe uncertainties undermine the 'isness' of histories and perhaps guide us towards responsibilities we never imagined.

In this section I want to focus more on the philosophical history which brought us here and how 20th century philosophy has tried to deal with the extreme uncertainties which face us. This story has not been written yet as it may not be writable but perhaps, we shall find it sayable. In any case, it is in its rough draft form at the present time. It took millenniums for the *epos*, the epic tale of our epoch(s) 'reality' to be written. Now I want to accelerate towards the direction of 20th century philosophy with more of a view to questions posed from that time on. We have still not yet begun to find our way to these ideas in popular culture. However, we have felt our way towards them in disruptions, challenges and changes to religious beliefs, cultural norms, the environment, democracies, sexuality, ethnic, gender, and disabled equality. The very power structures which ruled and demanded violent hierarchical order are like Humpty Dumpty. Either the 17th century term Humpty Dumpty applies to a drink of brandy boiled with ale, a short and clumsy person (or both) or,

Humpty Dumpty sat on a wall,
Humpty Dumpty had a great fall;
All the King's horses
And all the King's men,
Couldn't put Humpty together again.[158]

In my opinion Humpty Dumpty and quantum physics have much in common.

Our environmental problems alone are increasingly going to affect our immune systems, agricultural productivity, economic stability, ocean, and weather sustainability. We have also seen great achievements in medicine, automation, technology, education, robotics, artificial intelligence, quantum computing, and information accessibility. All of these changes have put immense pressures on sociological, cultural, and governmental viability and services. The rate of these changes imposed on communities brings stress and reactionary push back threatening regional and world security. Practicalities which enabled humans to make progress for

centuries are increasingly calling for more personal responsibility if we are to effectively respond to species survival threats. The sciences have made enormous progress.

As we have seen in physics and philosophy the scope of these changes has rendered classical and modernistic norms inadequate to a level which challenges us to even be able to be able to make sense; exactly what is being rendered senseless. Our ready-made historic settings have not equipped us to even begin to adequately find words and ideas, much less practical actions, for making cultural and individual sense out of the chaos and complexity of the abyss we face. As I discussed, classicism and modernity fitted us with notions of 'reality' which found practicality based on the sensing machine. Our sensing machines are born and die in an absolute space and time universe of cause and effect of matter, things, and substances bumping into the night. In the 20th century the sensing, thinking machine was becoming more and more obsolete in its abstractions. At this point I want to look at some 20th century philosophical schools. This century began to unravel some of the underlying assumptions of classicism. This was partly due to an emerging abyss of insufficiency - quantum mechanics.

Classicism's Exhaustion

The idea of the self has evolved and sustained itself in many ways through Western history. This is a very brief summary of the way the concept of self developed over the centuries. Notice in all the descriptions below how the self always has some relationship, a continuity, to or claim as essence and reality. All these histories were very different from what culminated in our conception of the self, 'me'. But a strain which runs through them is a sense of access, relatedness, and availability to fundamental truth concerning what we think as reality, essence, Being, etc. Analogously this functions a bit like special and general relativity. They stake out domains of narration in a smooth, continuous function of relatedness to light -

to reality, essence, Being, etc. The self is always consumed in an economy of relatedness to the absolute speed limit of light, to truth. I will give a brief summary here, but a more extended summary will be indicated in endnotes.

- Plato conceived of the absolute light as the Forms. Analogically, the Forms were the absolute speed limit of light The self has a rational soul (psyche). However, humans have a highly obscured understanding of absolute truth, shadows on the cave walls of the Forms. [i]
- Aristotle believed that intellect and reason were immortal and perpetual. This was the permanence of the self, analogically, the absolute speed limit of light. However, Aristotle believed this permanence was intricately linked to actuality, the materiality of the body. Becoming as a combination of potential and actual was not strictly a being because beings change. The soul is the form of the human body, but intellect and reason are the permanence which remains for change. [ii]
- Descartes believed in the mind/body binary dualism called the thinking thing. The rational, thinking soul was absolute truth, analogically, the absolute speed limit of light. The soul was immaterial, immortal, and conscious. The material body was an impermanent substance. [iii]
- Leibniz believed the self was an absolute monad with no exteriority. Analogically, the monad was the absolute speed limit of light. [iv]
- Isaac Newton was a devout Christian. Analogically, God was the absolute speed limit of light. The self was a creation of God. The self gets its identity from God. [v]

From Christian, religion and metaphysics, the self is creation, a child of God, with divine revelation. Revelation" (Latin *revelatio*) is a translation of the Greek word *apokalypsis*, which means the

removal of a veil so that something can be seen. 159 Epiphany is the knowledge of God. Analogically, God was the absolute speed limit of light.

From Enlightenment, there was a plethora of notions of the self and reality. This ranged from Christian ideas of God, mysticism, humanism, and Eastern philosophy. Dominant themes were reason, knowledge, freedom, and budding ideas of modernity in the British empiricists near the end of Enlightenment. Likewise, analogical notions of the absolute speed of light ranged from God to deism to humanism. Additionally, we see with the empiricists that analogical notions of the absolute speed of light first explicitly taking on the form of neutrality. Many of the empiricists of this era also believed in God but held that empirical observation beheld the light of a neutral universe. Here the self is cast off into agnosticism or merely personal preference. Empiricism challenged traditional notions of an unchanging, immortal soul. Instead, it emphasized the role of sensory experiences and the dynamic nature of our mental lives. The soul, according to many empiricists, is not a fixed essence but a product of our perceptions and consciousness. vi

Hegel is a very difficult thinker to ascertain an analogous absolute speed of light. The main reason for this is due to the wide variations in the schools of Hegel. The vertical schools would certainly tell us the analogous speed of light would be Hegel's idea of the Concept in his "Logic". However, the horizontal schools would disagree on this point. For them, the absolute speed of light would not be an Idea but a process the process of self-creation, of emergence and organic evolution. This would imply that no kind of absolute could take on any typical traditional meanings including the use of the term 'absolute'. It would also disregard neutrality as absolute. However, the process itself is a dialectic. In this sense there is a logical, smooth transition to different stages of becoming and the 'not' of having become. So, this would still fit into the continuity of a relativistic analogy. vii

From modernism, gathering together the logic of neutrality

wherein all meaning has been condensed and reduced into sheer isness. Neutrality like the *'is'* and its totalizing 'not' recognizes no externality. It is the bankruptcy of classicism into units of exchange. The only meaning to be derived is from transactionalism, the echo of the thinking thing. Even nature, our Roman inheritance, transacts with the currency of cause and effect. The uncaused as metaphysics is relegated to classicism's logic of negation in which no excess can remain. Meaning voids itself in the culminating neutrality of historic mediocrity.

It seems fitting that classicism finally gasps its 'not' as the age-old intuition of the absolute as the speed of light in relativity. Relativity ends the epoch of essences and truth with the silent star of the absolute speed of light. Everything in spacetime, even spacetime, is bent towards the speed of light, disappearing into the light. But the vast majority of spacetime is not light but darkness, the lingering, simmering night of the soul, vanished by the impoverished 'not' of classicism. But imperceptibly exceeding this final totality is quanta and its spooky function. This can no longer be light or its 'not' but an excess having no relation to continuous, smooth, and relative spacetime. Rather, irreconcilable disjuncture, without relation and relativity with some kind of spooky, hazy, chaotic branching, analogic confluences of many-worlds, multiverses – enumerable variations of possible actualizing narratives. But always excess, apart from observer effects, from selves, and yet, already simultaneously within the wave function's spooky externality. This is the gap we face at the end of history's epochs.

Phenomenological Transitions

In the early 20th century, physics's relativity found a new kind of spacetime from the absolute space and time of classicism. It found the spacetime is curved by the absolute speed limit of light. This spacetime is bent, has stretch, compression, and distortion, changes

the experience of temporality and extension. Reality is moldable to experience, to lived experience. Concurrently, phenomenology is born. Phenomenology as well as modernism had its early roots all the way back to the 17th century and perhaps even earlier. And as was the case for modernism, phenomenology also came into its own in the late 1800s with Husserl. In phenomenology, the concurrent findings of special and general relativity are accommodated with the effort to get back to how we find ourselves in actual living experiences. And from there phenomenology wants to investigate how meaning and significance may arise. Phenomenology brought on a banishment of modernist abstractions, the absolutes and essences of history, and back to perspectives of experiences. Modernism was the last gasp of classicism.

Often in the history of physics and philosophy there seems to be an interesting interplay between them in which both complement and expand each other's mutual areas of interest. The 20th century seems to be no different. Einstein's theory of relativity went against a centuries old idea called aether. Even in the 19th century, physics and philosophy held aether in esteem. Aether was both physical and spiritual. Aether was thought to pervade the universe almost like what we have called vacuum energy. It had a kind of unknown mystique perhaps a bit like how we think of dark energy today. Aether did function like a speed limit or smallest possible medium, but Einstein's special theory of relativity made it irrelevant due to his discoveries about the speed of light. Einstein's special theory of relativity in 1905 met with outright critics in physics, philosophy, and religion or he was simply ignored. But for some at the time Einstein's special relativity was just another rendition of the aether. However, the aether would shortly become an unnecessary holdover from the past.

> Eventually, Albert Einstein published in September 1905 what is now called special relativity, which was based on a radical new application of the relativity principle in

> connection with the constancy of the speed of light. In special relativity, the space and time coordinates depend on the inertial observer's frame of reference, and the luminiferous aether plays no role in the physics. Although this theory was founded on a very different kinematical model, it was experimentally indistinguishable from the aether theory of Lorentz and Poincaré, since both theories satisfy the relativity principle of Poincaré and Einstein, and both employ the Lorentz transformations. After Minkowski's introduction in 1908 of the geometric spacetime model for Einstein's version of relativity, most physicists eventually decided in favor of the Einstein-Minkowski version of relativity with its radical new views of space and time, in which there was no useful role for the aether.[160]

The 20th century's relativity destroyed the notions of absolute time and space which historically and metaphysically got intertwined with the absolute God of Christianity. In relativity time could no longer be unchanging and absolute. In quantum mechanics time does not exist and neither does the local realism of 'here'. Frank Wilczek, the American theoretical physicist and mathematician and Nobel laureate at MIT I discussed earlier tells us,

> As relativity undermines 'now', quantum theory undermines 'here'.[161]

When relativity relativized time and space to the inertial frame of the observer, many outspoken Christian evangelists proclaimed it as demonic heresy. While all this was going on against Einstein, modern phenomenology was born which Einstein seemed to favor. Einstein's general theory of relativity in 1915 also met with criticism but was mostly ignored for a number of years. A collection of essays was published in a book in 1931 which detailed criticisms

of relativity from many different disciplines. Here is more information about the book.

> A collection of various criticisms can be found in the book ""*Hundert Autoren gegen*" Einstein (One Hundred Authors Against Einstein), published in 1931. It contains very short texts from 28 authors, and excerpts from the publications of another 19 authors. The rest consists of a list that also includes people who only for some time were opposed to relativity. From among Einstein's concepts the most targeted one is space-time followed by the speed of light as a constant and the relativity of simultaneity, with other concepts following. Besides philosophic objections (mostly based on Kantianism), also some alleged elementary failures of the theory were included; however, as some commented, those failures were due to the authors' misunderstanding of relativity. For example, Hans Reichenbach wrote a report in the entertainment section of a newspaper, describing the book as "a magnificent collection of naive mistakes" and as "unintended droll literature." Albert von Brunn interpreted the book as a pamphlet "of such deplorable impotence as occurring elsewhere only in politics" and "a fallback into the 16th and 17th centuries" and concluded "it can only be hoped that German science will not again be embarrassed by such sad scribblings", and Einstein said, in response to the book, that if he were wrong, then one author would have been enough.
>
> According to Goenner, the contributions to the book are a mixture of mathematical–physical incompetence, hubris, and the feelings of the critics of being suppressed by contemporary physicists advocating the new theory. The compilation of the authors show, Goenner continues, that this was not a reaction within the physics community—only one physicist (Karl Strehl) and three mathematicians (Jean-

> Marie Le Roux, Emanuel Lasker and Hjalmar Mellin) were present—but a reaction of an inadequately educated academic citizenship, which did not know what to do with relativity. As regards the average age of the authors: 57% were substantially older than Einstein, one third was around the same age, and only two persons were substantially younger. Two authors (Reuterdahl, von Mitis) were antisemitic and four others were possibly connected to the Nazi movement. On the other hand, no antisemitic expression can be found in the book, and it also included contributions of some authors of Jewish ancestry (Salomo Friedländer, Ludwig Goldschmidt, Hans Israel, Emanuel Lasker, Oskar Kraus, Menyhért Palágyi).[162]

As mentioned, starting at the same time Einstein faced a lot of scientific and religious opposition early on and with his later general theory of relativity. Anti-Semites attacked his theory and him personally. Einstein's relativity sparked a lot of religious indignation in the early 20th century. Einstein was associated with politically left ideologies including the struggle of civil rights for African Americans. He was well versed in philosophy and wrote about it. Kantians criticized Einstein's spacetime theory as Kant's *a priori* Categories of Understanding seemed to contradict relativity. In 1924 Einstein responded to the Kantians with this,

> Until some time ago, it could be regarded as possible that Kant's system of a priori concepts and norms really could withstand the test of time. This was defensible as long as the content of later science held to be confirmed*) did not violate those norms. This case occurred indisputably only with the theory of relativity. However, if one does not want to assert that relativity theory goes against reason, one cannot retain the a priori concepts and norms of Kant's system.

[Footnote] *) To refute Kant's system it actually suffices to indicate a logically conceivable theory (corresponding to conceivable observational material) that conflicts with Kantian norms. Whether non-Euclidean geometries accomplished this remained controversial.

For starters, this does not exclude, at least, the retention of Kant's way of posing the problem, as Cassirer, for instance, does. I am even of the opinion that this standpoint cannot be strictly refuted by any scientific development. For, one will always be able to say that critical philosophers had hitherto erred in setting up the a priori elements and one will always be able to set up a system of a priori elements that does not conflict with a given physical system. I surely may briefly indicate why I do not find this standpoint natural. Let a physical theory consist of the parts (elements) A, B, C, D, which together form a logical whole that correctly connects the pertinent experiments (sensory experiences). Then the tendency is that less than all four elements, e.g., A, B, D, still say nothing about the experiences, without C; no more so A, B, C, without D. One is then free to regard three of these elements, e.g., A, B, C, as a priori and only D as empirically determined. What always remains unsatisfactory in this is the arbitrariness of the choice of elements to be designated as a priori, even disregarding that the theory could be replaced at some point by another theory that substitutes some of these elements (or all four of them) with others. One could be of the view, though, that through direct analysis of human reason, or thought, we would be in a position to recognize elements that would have to be present in any theory. But most researchers would probably agree that we lack a method for recognizing such elements, even if one were inclined to believe in their existence. Or should one imagine that the search for a priori elements was a kind of asymptotic process that advances along with the development of

science?[163]

Effectively, Einstein uses Karl Popper's argument that religion is unfalsifiable on the Kantians. Einstein tells us that Kant's Categories of Understanding as mentioned earlier [quantity (unity, plurality, totality), quality (reality, negation, limitation), relation (inherence and subsistence (substance and accident), causality and dependence (cause and effect), community (reciprocity), and modality (possibility, existence, necessity)] were thought by Kant as pre-conditioning thinking. These categories were *a priori* so there would be no way to stand outside of them to critique them since thinking itself is already conditioned by the categories. This made the categories unfalsifiable. Einstein seems to indicate in the quote above that even if specifics of the categories were changed or eliminated, according to Kant the *a priori* assumption could not be proven false. If something is asserted as prior to existence as merely an assertion, without evidence, how could it possibly be falsifiable? Think about trying to disprove religious dogma. It is ironic that in the case of exformation which Einstein himself was largely responsible for simultaneously recognizing and criticizing (e.g. in search of a unified field theory), we do have a case of information as *a priori*. What is the difference?

Exformation has empirical evidence which has had substantial recent histories which experimentally verify drawing these conclusions. This satisfies the empiricist conditions for knowing. Certainly, there could be future evidence which could de-spook entanglement but more and more this seems unlikely. There are a minority of physicists which are still actively trying to find alternate explanations but for the majority of physicists this seems to be a settled issue. For entanglement to be anything like a 'settled issue' in physics it has to have undergone many decades of verifiable, repeatable, and exhaustive searching for alternative solutions which do not have the 'spook' factor. There are some professors who actively try to teach entanglement by downplaying its implications,

restricting their mentoring to more strict mathematical terms. This is certainly understandable for students making their careers in physics. However, in the view of many famous and not so famous physicists who allow themselves to engage in philosophical implications there are solid reasons why exformation implies massive historic, social, and philosophical consequences. Falsifiability must always be a foundation of science for science to be science. Additionally, initial findings in science most often are abstract. If these findings survive the test of time, they tend to become more concrete and simpler like Einstein's famous $e = mc^2$. Philosophy has a fundamentally different basis than science.

On Husserl

Aristotle's "Physics" and "Metaphysics" books show us why philosophy can never be purely empirical as the Positivists claimed. As mentioned earlier, Einstein was fully aware of why philosophy could not be reduced to empiricism. I also think philosophy should never be exempt from falsifiability or more precisely, critical systemic questions and shortcomings in any particular philosophical system. Even as Positivism anchored scientific findings in phenomenal observations which can never be considered complete, Socratic ignorance must be the foundation of philosophy so that it does not lapse into dogmatism. Edmund Husserl (1859-1938) founded phenomenology as an empirical science of science. His motto was "back to things themselves" not historic abstractions but rigorous and bracketed from historic biases focus on lived phenomenon.

> In the first decade of the 20th century, Husserl considerably refined and modified his method into what he called "transcendental phenomenology". This method has us focus on the essential structures that allow the objects naively taken for granted in the "natural attitude" (which is

characteristic of both our everyday life and ordinary science) to "constitute themselves" in consciousness. (Among those who influenced him in this regard are Descartes, Hume and Kant.) As Husserl explains in detail in his second major work, Ideas (1913), the resulting perspective on the realm of intentional consciousness is supposed to enable the phenomenologist to develop a radically unprejudiced justification of his (or her) basic views on the world and himself and explore their rational interconnections…

As a philosopher with a mathematical background, Husserl was interested in developing a general theory of inferential systems, which (following Bolzano) he conceived of as a theory of science, on the ground that every science (including mathematics) can be looked upon as a system of propositions that are interconnected by a set of inferential and grounding relations. Following John S. Mill, he argues in Logical Investigations that the best way to study the nature of such propositional systems is to start with their linguistic manifestations, i.e., (sets of) sentences and (assertive) utterances thereof.

How are we to analyse these sentences and the propositions they express? Husserl's approach is to study the units of consciousness that the respective speaker presents himself as having—that he "gives voice to"—in expressing the proposition in question (for instance, while writing a mathematical textbook or giving a lecture). These units of consciousness he labels intentional acts or intentional experiences, since they always represent something as something—thus exhibiting what Brentano called intentionality. According to Husserl, there are non-intentional units of consciousness as well. (He quotes pain as an example.) What distinguishes intentional from non-intentional experiences is the former's having intentional content. 164

There is strong evidence that Einstein was aware of what Husserl was doing in phenomenology. In 1905, the same year as Einstein's special theory of relativity, Edmund Husserl founded the school of modern phenomenology. Much of Einstein's language discussed by the paper below reflects an in-depth knowledge of what Husserl and his student Martin Heidegger were working on. The bold indicates that Einstein had a sympathetic view of the budding philosophies of phenomenology. Also, note in this text that the positivists found Einstein to be an existential threat to science.

> In an unpublished manuscript from the same year as Husserl's Crisis, Einstein seems to turn to this phenomenological problem using the same Husserl's terminology:
>
> Science as something existing, confectioned, is more than something of **objectivized and, at the same time, impersonalized that we as human beings know in general**. Science as something becoming, as destination, is also **equally subjective, psychologically conditioned** as all the other human aspirations. (…) Naturally there are people who affirm that science has produced a too high connection among experiencing **facts** [erlebbaren], so we can deduce **from experienced facts other experiencing facts**. According to the opinion of some positivists, the possible solution of such assignment would be the unique end of science. (…) There is in fact a stronger and, for this reason, also darker impulse behind these assiduous disputes: the will of understanding Being, the Reality. However, it seems that we have avoided using such words, since we are really embarrassed in clarifying what we must properly intend for real [Wirklich] and what we must understand [begreifen] in this general affirmation. All these efforts are founded upon the trust that Being in its structure is incomplete harmony.
>
> Referring himself to Husserl's phenomenology – as I think

– Einstein concludes that:

> (…) **In our time a new and original thought is beginning to emerge. If this time has produced a progress of the epistemological sphere, so in fact it seems to me that we could not give for granted any reasonable ways that brings us from the Erleben (experiencing) to the conceptual Erfassen (knowledge) of things, since every thought is founded on a free theoretical construction, which systematically derives through sense experiences.** 165

The latter quote by Einstein appears to show an in-depth knowledge of Husserl's work. The German words Erleben (experiencing) and Erfassen (knowledge) are at the root of Husserl's phenomenological investigations. Particularly, why are human experiences rejected from the science of 'things'? Husserl's motto was back to the things themselves or the way we intentionally orient ourselves to phenomenon. Einstein seems to validate the effort to reevaluate thought with regard to sense experience.

From Einstein's quote, the Positivists opposed anything *a priori* such as Kant's Categories of Understanding. For the Positivists, this kind of truth was true by definition such as metaphysics or *a posteriori* meaning already 'empirically' determined. What was meant by empiricism for the Positivists? As empirical, science was falsifiable and not mere assertions of dogmatism, unfalsifiable. Additionally, Einstein points out that the Positivists were incapable of understanding any such notion as 'Being'. Being was the main concern of Heidegger's early work "Being and Time". We have previously used the term epoch to indicate an age. Now I would like to introduce the term '*epoché'*. How did we get epoch from epoché?

> Epoch comes to us, via Medieval Latin, from Greek epochē, meaning "cessation" or "fixed point." "Epochē," in turn, comes from the Greek verb epechein, meaning "to pause" or "to hold

> back." When "epoch" was first borrowed into English, it referred to the fixed point used to mark the beginning of a system of chronology. That sense is now obsolete, but today "epoch" is used in some fields (such as astronomy) with the meaning "an instant of time or a date selected as a point of reference." The "an event or a time that begins a new period or development" sense first appeared in print in the early 17th century, and "epoch" has been applied to defining moments or periods of time ever since. 166

For Husserl *epoché* means,

1. Moment of theoretical suspension of all action.
2. Moment of theoretical suspension of disbelief. 167

Epoché refers to a fundamental technique that goes beyond mere abstraction and examination of essences. It serves to highlight consciousness itself by suspending trust in the objectivity of the world. In Hellenistic philosophy, epoché plays a crucial role in Pyrrhonism, a skeptical philosophy. Pyrrhonists use it to suspend judgment about non-evident matters, aiming for a state of ataraxia —freedom from worry and anxiety. Sextus Empiricus, a Pyrrhonist philosopher, defines epoché as a state of intellect where we neither deny nor affirm anything. The Pyrrhonists employ techniques like the Ten Modes of Aenesidemus, the Five Modes of Agrippa, and Pyrrhonist maxims to achieve epoché. In Stoicism, epoché describes withholding assent to Phantasia (impressions). Epictetus explains that epoché involves feeling uncertainty, neither affirming nor denying, but recognizing the indeterminacy of a situation. Edmund Husserl introduced epoché as a systematic procedure in his work Ideas I. Through phenomenological reduction, practitioners suspend judgment regarding the existence of the external world. This allows them to examine phenomena as they are originally given to consciousness. Husserl distinguishes between universal epoché

(leaving behind all assumptions of existence) and local epoché (setting aside specific assumptions). The former has a stronger effect than the latter. For Husserl, epoché serves as a tool for exploring consciousness, questioning assumptions, and gaining deeper insights into our experience of reality. [168] Husserl used the word *epoché* to mean 'bracket'. Husserl asks us to bracket our individual assumptions about our normal everyday life.

> The modern founder of phenomenology is the German philosopher Edmund Husserl (1859–1938), who sought to make philosophy "a rigorous science" by returning its attention "to the things themselves" (zu den Sachen selbst). He does not mean by this that philosophy should become empirical, as if "facts" could be determined objectively and absolutely. Rather, searching for foundations on which philosophers could ground their knowledge with certainty, Husserl proposes that reflection put out of play all unprovable assumptions (about the existence of objects, for example, or about ideal or metaphysical entities) and describe what is given in experience. The road to a presuppositionless philosophy, he argues, begins with suspending the "natural attitude" of everyday knowing, which assumes that things are simply there in the external world. Philosophers should "bracket" the object-world and, in a process he calls epoché, or "reduction," focus their attention on what is immanent in consciousness itself, without presupposing anything about its origins or supports. Pure description of the phenomena given in consciousness would, Husserl believes, give philosophers a foundation of necessary, certain knowledge and thereby justify the claim of philosophy to be more radical and all-encompassing than other disciplines (see Ideas 95–105 and Meditations 11–23). [169]

Husserl's phenomenology involved not theorizing about what **is** the case in any way. It also meant not simply taking, for example, classical science's findings (e.g. absolute time and space) as relevant. Husserl wanted to get back to the phenomenon itself in perception and experience. This is where lived time and lived space found relevance. In my view of Husserl, the notions of lived body and lifeworld were intentional objects which wanted to downplay the copula, the determinate *is* in experience, in sensuality. **Sensibility is not sensuality.** I will use these words carefully in everything which follows to keep this difference clear. For Husserl, sensuality was how we live as 'affect', as feeling, as immediate lived experience. This is what we mean as sensuality. For Husserl, sensibility arises from sensuality taken up into intentionality.

Husserl delved into the intricate realms of consciousness and perception. Husserl believed that life primarily consists of the immanent mental life of a subject. This life encompasses both conscious and unconscious dimensions. The conscious aspects involve our direct awareness, thoughts, and experiences. The unconscious aspects, however, remain hidden from immediate awareness but play a crucial role in shaping our mental life. In his later works, Husserl emphasized the importance of understanding life as a whole, including its unconscious layers. For Husserl, the unconscious is not limited to mere sensory data (hyletic sensations). It extends beyond that. It encompasses perceptual unities, structures, thoughts, and even memories. In his work entitled "Analyses of Passive Synthesis", Husserl explored various meanings of the unconscious. Husserl's notion of life is closely tied to embodiment. Life is not an abstract concept; it is inherently connected to our bodily existence. He considered life as the pure immanent life of subjectivity or consciousness. Through his genetic phenomenology, Husserl aimed to understand the a priori conception of experiential genesis. Life, according to him, involves both conscious and unconscious elements, and it is through this life that we engage with the world. From a Husserlian perspective, we

are part of a universal community of living beings. As self-conscious rational subjects, we can acquire apodictically self-evident ethical insights. These insights guide us toward ethical authenticity and responsibility, even in our interactions with non-human and non-conscious beings. Husserl's exploration of sensuality goes beyond sensory data, touching upon the intricate interplay of consciousness, embodiment, and ethical understanding within the fabric of life. 170

> Husserl compares this process of intentional "forming" of sensual matter to the interpretation of a linguistic expression, but this comparison should not mislead us to conclude that he subscribes to a sense-datum theory of perception (see Section 2 above, headword: mental image theory). Rather, his view on perception is best characterized as a sophisticated version of direct (i.e., non-representationalist) realism. 171

Husserl focused on the lived experience of intentionality.

> In Logical Investigations Husserl developed a view according to which conscious acts are primarily intentional, and a mental act is intentional only in case it has an act-quality and an act-matter. Introducing this key distinction, Husserl writes:
>
> The two assertions '2 x 2 = 4' and 'Ibsen is the principal founder of modern dramatic realism', are both, qua assertions, of one kind; each is qualified as an assertion, and their common feature is their judgment-quality. The one, however, judges one content and the other another content. To distinguish such 'contents' from other notions of 'content' we shall speak here of the matter (material) of judgment. We shall draw similar distinctions between quality and matter in the case of all acts.
>
> An additional notion in the Investigations, which grows in

> importance in Husserl's later work and will be discussed here, is the act-character. Husserl views act-quality, act-matter and act-character as mutually dependent constituents of a concrete particular thought. Just as there cannot be color without saturation, brightness and hue, so for Husserl there cannot be an intentional act without quality, matter and character. The quality of an act (called 'intentional act' above) is the kind of act that it is, whether perceiving, imagining, judging, wishing, and so forth. The matter of an act is what has been called above its intentional content, it is the mode or way in which an object is thought about, for example a house intended from one perspective rather than another, or Napoleon thought of first as "the victor at Jena", then as "the vanquished at Waterloo". The character of an act can be thought of as a contribution of the act-quality that is reflected in the act-matter. Act-character has to do with whether the content of the act, the act-matter, is posited as existing or as merely thought about and with whether the act-matter is taken as given with evidence (fulfillment) or without evidence (emptily intended). 172

Modernity assembled objects into an abstract objective world for a subject. Husserl's lifeworld was the science of how human experience can assemble any such thing as modernity's science.

> Among the fundamental beliefs thus uncovered by Husserl is the belief (or expectation) that a being that looks and behaves more or less like myself, i.e., displays traits more or less familiar from my own case, will generally perceive things from an egocentric viewpoint similar to my own ("here", "over there", "to my left", "in front of me", etc.), in the sense that I would roughly look upon things the way he does if I were in his shoes and perceived them from his perspective. This belief allows me to ascribe intentional acts

> to others immediately or "appresentatively", i.e., without having to draw an inference, say, by analogy with my own case. So the belief in question must lie quite at the bedrock of my belief-system. It forms a part of the already pregiven (and generally unreflected) intentional background, or "lifeworld" (cf. Crisis), against which my practice of act-ascription and all constitutive achievements based upon that practice make sense in the first place, and in terms of which they get their ultimate justification. [173]

The lifeworld had two senses to it. It had personal beliefs, opinions, or intentions projected into what Husserl calls intentionality. It also had a collective sense where intentionality congeals into society, history, language, etc.

> Husserl's notion of lifeworld is a difficult (and at the same time important) one. It can roughly be thought of in two different (but arguably compatible) ways: (1) in terms of belief and (2) in terms of something like socially, culturally or evolutionarily established (but nevertheless abstract) sense or meaning. [174]

Here is a brief but more detailed explanation of these two notions.

> (1) If we restrict ourselves to a single subject of experience, the lifeworld can be looked upon as the rational structure underlying his (or her) "natural attitude". That is to say: a given subject's lifeworld consists of the beliefs against which his everyday attitude towards himself, the objective world and others receive their ultimate justification. (However, in principle not even beliefs forming part of a subject's lifeworld are immune to revision. Hence, Husserl must not be regarded as an epistemological foundationalist; see Føllesdal

1988.)

(2a) If we consider a single community of subjects, their common lifeworld, or "homeworld", can be looked upon, by first approximation, as the system of senses or meanings constituting their common language, or "form of life" (Wittgenstein), given that they conceive of the world and themselves in the categories provided by this language.

(2b) If we consider subjects belonging to different communities, we can look upon their common lifeworld as the general framework, or "a priori structure", of senses or meanings that allows for the mutual translation of their respective languages (with their different associated "homeworlds") into one another.

The term "lifeworld" thus denotes the way the members of one or more social groups (cultures, linguistic communities) use to structure the world into objects (Husserliana, vol. VI, pp. 126–138, 140–145). The respective lifeworld is claimed to "predelineate" a "world-horizon" of potential future experiences that are to be (more or less) expected for a given group member at a given time, under various conditions, where the resulting sequences of anticipated experiences can be looked upon as corresponding to different "possible worlds and environments". 175

When worldviews begin to break down, they not only become less functional, but they also become more abstract. That is, they no longer seamlessly allow practicality. Another way to think of Husserl's intentionality is as a movement away from abstraction towards the concrete experience of lived human phenomena. How does experience come to us? Is it as concepts or simple practicality which need no further elaboration? Practical acts are not mere mindless movements but always, already assume specific contexts. The context brought to the fore in $2 + 2 = 4$ is different from the context of the 19th century playwright Ibsen's juxtaposition of

modernism and the idealism of Hegel contrasted with the iconoclasm of Nietzsche's anti-idealism. 176 Here Husserl does not want to debate the specific themes, the 'facts of the case', he wants to think about the lived modalities in which these different kinds of contextual relationships occur. Intentional acts have qualities ranging from evidentiary-based to wishful (without evidence). But what is 'evidence' for Husserl? For Plato evidence was the shadows of what is seen emanating from what is not seen, the forms. For Descartes evidence was the thinking thing, the *cogito*, which cannot doubt that it thinks.

> While, in Descartes, the concept of evidence meant "seeing" something without any doubt, in Husserl it does not have a single meaning as apodictic [my comment, absolute] certainty. This is due to the fact that Husserl used evidence in two different but closely interrelated senses. Husserl did not separate experience and evidence. That is why evidence emerged as a form of consciousness, an intentionality, in Husserl. This intentional act resembles the structure of lives and acts of consciousness, the periphery of consciousness, and life with such a structure is determined to be the consciousness of something. Husserl explains such an intentional experience (that is, intentionality) as "being directed towards something aimed at", "being turned to something". Evidence thus is, in fact, a form of consciousness, an intentionality. Intentionality and evidence are, for this reason, two concepts which are, to some extent, concurrent in the philosophy of Husserl. 177

In this way Husserl is more a psychologist of living phenomenon than a theorist of philosophical or ideological propositions. However, let's note here that experiential observation is not so unlike scientific experimental observation with the exception of the specific context of mathematical repeatability. However, the motifs

or contexts which science allows cannot account for such repeatable notions as cultural values, narratives of history, and ways language shapes perception. We do see the effects of all these in science in the forms of competing scientific paradigms which always contextually underlie the assumptions wherein phenomenon is allowed to show itself in science. One such example of this is how classic physics allowed scientific discovery to come to the fore. We see this effect in Einstein's belief that quantum physics was lacking due to uncertainty and needed the classic notion of locality to complete it. So, what is it that orients us in the world where science, religion, culture, language, and history orient us? For Husserl it was the body and the 'lifeworld'.

> According to Husserl, it is the body which provides orientation ; man's intentionality is possible thanks to the body. A person's body is, therefore, essentially important in phenomenology. It is the centre for orientation. According to Husserl, who emphasizes the unity of the soul and the body by pointing out that "the body is all I possess", and who claims that the "I" is a whole composed of the soul and the body, there are two features of the physical organism. These two features cannot be thought of apart. The body is, firstly, an organ for perception and demand. I perceive anything through my body, which is an organism that belongs to me. If my body were not a whole made up of individual organs, nothing would exist. My body, for this reason, is a prerequisite for the world to exist. I am, therefore, dependent on a centre of orientation, and thus on my body, in whatever I perform. This centre of orientation is originally bestowed upon me with every turn I take. I am unable to perform without my body. According to Husserl, whatever one perceives, wherever one goes, one experiences everything with respect to the relationship between oneself and one's body. Such dimensions as "over", "below", "right", "left" and

so forth derive meaning only in relation to my body. 178

Husserl's motto of 'back to things in themselves' meant back to our concrete experience as embodied. So, in this sense Husserl looked at phenomenology as archeology. Unearthing artifacts of lived experience was the process of phenomenology. However, even the phenomenologist's observation conditioned what showed itself as lived experience and lifeworld. Is this so unlike quantum physics' complementarity idea where experimental observation has a determinacy which conditions what it observes but says nothing about absolute 'reality' when not being observed? However, just as quantum observation is not some sort of mere subjectivity so phenomenology derives a sense of agreement not necessarily from some kind of 'pure' detached scientific observation, so culture, language, and history have a determinate kind of arena where judgements can more or less find agreement.

> In experience we become conscious of a thing. Evidence, on the other hand, is an act of consciousness which gives (presents) a thing – that is, brings about an experience. Thus, evidence is the name for experiencing which may have various degrees or grades of adequacy. Therefore, according to Husserl, there is no one evidence, but many evidences or experiences. There also are evidences which are relative, which are not certain, allowing for doubt one way or the other, which in fact depend upon other experiences, which are not consistent, and which thus leave some aspects in the dark, or even appear altogether wrong in the end, as a result of which "what" is shown is exposed as "nothing" 179

On Heidegger

Martin Heidegger (1889-1976), a student of Husserl, addresses the matter of presuppositions in "Being and Time". Heidegger would

rather propose understanding as “ahead of itself” as “*projecting expectations that interpretation then makes explicit”* from a past, a “forestructure”, which has already made a specific understanding possible.

> Later phenomenologists have been skeptical of Husserl’s contention that description can occur without presuppositions, in part because of Husserl’s own analysis of the structure of knowledge. According to Husserl, consciousness is made up of "intentional acts" correlated to "intentional objects." The "intentionality" of consciousness is its directedness toward objects, which it helps to constitute. Objects are always grasped partially and incompletely, in "aspects" (Abschattungen) that are filled out and synthesized according to the attitudes, interests, and expectations of the perceiver. Every perception includes a "horizon" of potentialities that the observer assumes, on the basis of past experiences with or beliefs about such entities, will be fulfilled by subsequent perceptions (see Meditations 39–46).
>
> Extrapolating from Husserl’s description of consciousness, Martin Heidegger(1889–1976) argues that understanding is always "ahead of itself" (sich vorweg), projecting expectations that interpretation then makes explicit. In the section "Understanding and Interpretation" in Being and Time (1927) Heidegger argues that inherent in understanding is a "forestructure" (Vorstruktur) of assumptions and beliefs that guide interpretation. Heidegger’s account of the interdependence of understanding and expectations is in part a reformulation of the classic idea that interpretation of texts is fundamentally circular, inasmuch as in interpretation the construal of a textual detail is always necessarily based on assumptions about the whole to which it belongs (see Palmer and hermeneutics). His theory of understanding also reflects his own assumptions

about human existence, which he describes as a process of projection whereby we are always outside of and beyond ourselves as we direct ourselves toward the future. Heidegger's conception of the anticipatory structure of understanding is important for later versions of phenomenology that focus on interpretation and reading. Hermeneutic phenomenology (especially as developed by Hans-Georg Gadamer and Paul Ricoeur) further the role of presuppositions in understanding, and phenomenological theories of textual reception (especially the "Constance school," led by Hans Robert Jauss and Wolfgang Iser) investigate how literary works are understood differently by audiences with different interpretive conventions (see reader-response theory and criticism and reception theory). 180

Let's recall our discussion on Aristotle's idea of primary and secondary or accidental being. Heidegger thinks that Aristotle was on the right track but mistook being as presence. Heidegger takes Being to be more fundamental than what comes to presence.

Each of these aspects of Heidegger's framework in Being and Time emerges out of his radical rethinking of Aristotle, a rethinking that finds its fullest and most explicit expression in a 1925–6 lecture course entitled Logik (later renamed Logik (Aristoteles) by Heidegger's student Helene Weiß, in order to distinguish this lecture course from a later one he gave also entitled Logik; see Kisiel 1993, 559, note 23). On Heidegger's interpretation (see Sheehan 1975), Aristotle holds that since every meaningful appearance of beings involves an event in which a human being takes a being as—as, say, a ship in which one can sail or as a god that one should respect—what unites all the different modes of Being is that they realize some form of presence (present-ness) to human beings. This presence-to is expressed in the 'as' of

> ‘taking-as’. Thus the unity of the different modes of Being is grounded in a capacity for taking-as (making-present-to) that Aristotle argues is the essence of human existence. Heidegger's response, in effect, is to suggest that although Aristotle is on the right track, he has misconceived the deep structure of taking-as. For Heidegger, taking-as is grounded not in multiple modes of presence, but rather in a more fundamental temporal unity (remember, it's Being and time, more on this later) that characterizes Being-in-the-world (care). This engagement with Aristotle—the Aristotle, that is, that Heidegger unearths during his early years in Freiburg and Marburg—explains why, as Sheehan (1975, 87) puts it, “Aristotle appears directly or indirectly on virtually every page” of Being and Time. (For more on Heidegger's pre-Being-and-Time period, see e.g., Kisiel 1993, Kisiel and van Buren 1994, and Heidegger's early occasional writings as reproduced in the collection Becoming Heidegger. For more on the philosophical relationship between Husserl and Heidegger, see e.g., Crowell 2001 and the review of Crowell's book by Carman 2002; Dahlstrom 1994; Dostal 1993; Overgaard 2003.) [181]

What does Heidegger think is more fundamental? Heidegger tells us,

> “dasein [the there of being, existent beings] is ontically [in the particular sense of a lived being] distinguished by the fact that, in its very Being, that Being is an issue for it” (Being and Time 4: 32). [182]

Heidegger’s whole early work in ‘Being and Time’ is to try to uncover an ontological meaning to being. In other words, he wants to try to clarify what it is that makes us, individual beings, have a peculiar concern for Being. Capitalizing ‘Being’ here is simply to

point toward and describe why we are so concerned about 'what's it all about'. Heidegger thinks Aristotle tried to strain this idea through his kind of empirical sense of how beings show themselves in nature. By 'showing themselves in nature' we mean how they appear. This is what he is referring to as presence. Heidegger thinks that there is a circularity which is endemic to thinking about Being. He calls this circularity the hermeneutical circle. Hermes was the interpreter between earth and the underworld. The hermeneutical circle is an inquiry wherein the 'there' of being, us, uncovers more and more about our odd condition where Being is an issue for us. This circularity cannot be taken into presence as some kind of object in nature as present-at-hand as Aristotle tried to do. Below is a quote from a more difficult and technical writing of Heidegger but first I will first try to make it more accessible:

- Notice how being, both capitalized and not, are treated in this text.
- *dasein* is German for the 'there of being' or human being.
- Anxiety is the withdrawal of Being from *Dasein*, the 'there of [a] being'.
- We are thrown as the 'there' of being, as *Dasein*.
- Thrownness is always spread over time from a past in a present towards projection, towards a future.
- Resoluteness, projecting, and taking hold of one's authenticity may have some kinship to Husserl's notion of intentionality and quality although this would be debated among scholars.
- Authenticity is taking hold in resolute-ness of one's being.
- Care is the resolute–ness of taking hold of one's authentic being.

> We have defined "resoluteness" as a projecting of oneself upon one's own Being-guilty—a projecting which is reticent and ready for anxiety.(iv) Resoluteness gains its authenticity

as anticipatory resoluteness.(v) In this, Dasein understands itself with regard to its potentiality-for-Being, and it does so in such a manner that it will go right under the eyes of Death in order thus to take over in its thrownness that entity which it is itself, and to take it over wholly. The resolute taking over of one's factical 'there', signifies, at the same time, that the Situation is one which has been resolved upon. In the existential analysis we cannot, in principle, discuss what Dasein factically resolves in any particular case. Our investigation excludes even the existential projection of the factical possibilities of existence. Nevertheless, we must ask whence, in general, Dasein can draw those possibilities upon which it factically projects itself. One's anticipatory projection of oneself on that possibility of existence which is not to be outstripped—on death—guarantees only the totality and authenticity of one's resoluteness. But those possibilities of existence which have been factically disclosed are not to be gathered from death. And this is still less the case when one's anticipation of this possibility does not signify that one is speculating about it, but signifies precisely that one is coming back to one's factical "there". Will taking over the thrownness of the Self into its world perhaps disclose a horizon from which existence snatches its factical possibilities away?(1) Have we not said in addition that Dasein never comes back behind its thrownness?(vi) Before we decide too quickly whether Dasein draws it authentic possibilities of existence from thrownness or not, we must assure ourselves that we have a full conception of thrownness as a basic attribute of care. 183

I am not going to try to decipher Being and Time in this book so I will try to give a more relatable account of this quote to folks who are not acclimated to academic philosophy. When Being becomes reality and practicality (the 'there' of Being) it becomes

everydayness in Heidegger's terminology. It becomes what I refer to as absolute. It has a kind of certainty which Heidegger refers to as inauthentic. I would add that it simultaneously relieves existential tension and exhausts existential tension to the point of fatigue and exasperation [anxiety]. Contrarily, when space is abstracted as three dimensions of length, width and height traveling through one dimension of time there is no messy concrete or lived middle which makes these relationships more dubious. Time and space have been mechanized. In practical effect, they become absolutely apparent [this is more akin to inauthenticity for Heidegger or ontic (the particular of ontological) everydayness of the 'there' of being]. This makes the notions of local realism self-evident. The cosmos is thought to be ordered and chaos has been vanquished. Such historic certainties imply an endless repetition of 'mere' ritual reenactments without the possibility of contextual reflection (everydayness). In my estimation this creates a facade where the rules are known, and the game becomes game theory.

Whoever negotiates the rule-scape better is promised to reap the benefits. The only value becomes transactionalism or playing the game better than others. Benefit is at the expense of others. Fatigue is the end result of repetition where the rules have no possibility for excess. The facade of excess is given at the expense of the other. This is the definition of transactional mechanism, survival of the fittest machine. Note that I started this discussion with the *meta* of mechanism and ended it with mechanism defining being, in particular, the sense of 'my being'. I have become the victim of a certain history which gets reduced to mere repetition. The result of this lived desperation becomes the source of social power structures and their inevitable violences. Philosophy is the historic questioning of our contextual assumptions. These assumptions walk hand in hand through our history with assumptions built into the history of science as well.

When Einstein questioned the relativity of absolute time and space, philosophy was simultaneously questioning the certainty of

the absoluteness of the lived context in which 'reality' was implicitly taken as ready-to-hand, as a tool which blindly validated or invalidated behavior. As a student of Husserl, Martin Heidegger exemplified the thought of ready to hand as a context in which we are related to being as a tool, a hammer.

> The less we just stare at the hammer-thing, and the more we seize hold of it and use it, the more primordial does our relationship to it become, and the more unveiledly is it encountered as that which it is—as equipment. The hammering itself uncovers the specific 'manipulability' of the hammer. The kind of Being which equipment possesses—in which it manifests itself in its own right—we call 'readiness-to-hand'. (Being and Time 15: 98) [184]

Heidegger refers to this mode of living embodiment with the other as ready-to-hand, *Zuhandenheit,* in which the other has already disappeared into use value. Here is how Heidegger introduces the idea of ready-to-hand in "Being and Time",

> The ready-to-hand is not grasped theoretically at all, nor is it itself the sort of thing that circumspection takes proximally as a circumspective theme [my clarification i.e, with explicit contextuality]. The peculiarity of what is proximally ready-to-hand is that, in its readiness-to-hand, it must, as it were, withdraw [zurückzuziehen] in order to be ready-to-hand quite authentically. That with which our everyday dealings proximally dwell is not the tools themselves [die Werkzeuge selbst]. On the contrary, that with which we concern ourselves primarily is the work—that which is to be produced at the time; and this is accordingly ready-to-hand too. The work bears with it that referential totality within which the equipment is encountered.
>
> The work to be produced, as the "towards-which" of such

things as the hammer, the plane, and the needle, likewise has the kind of Being that belongs to equipment. The shoe which is to be produced is for wearing (footgear) [Schuhzeug]; the clock is manufactured for telling the time. The work which we chiefly encounter in our concernful dealings—the work that is to be found when one is "at work" on something [das in Arbeit befindliche]—has a usability [my clarification i.e, practicality] which belongs to it essentially; in this usability it lets us encounter already the "towards-which" [my clarification i.e, Huserl's intentionality] for which it is usable . A work that someone has ordered [das bestellte Werk] is only by reason of its use and the assignment-context of entities which is discovered in using it.

But the work to be produced is not merely usable for something. The production itself is a using of something for something. In the work there is also a reference or assignment to 'materials': the work is dependent on [angewiesen auf] leather, thread, needles, and the like. Leather, moreover is produced from hides. These are taken from animals, which someone else has raised. Animals also occur within the world without having been raised at all; and, in a way, these entities still produce themselves even when they have been raised. So in the environment certain entities become accessible which are always ready-to-hand, but which, in themselves, do not need to be produced. Hammer, tongs, and needle, refer in themselves to steel, iron, metal, mineral, wood, in that they consist of these. In equipment that is used, 'Nature' is discovered along with it by that use—the 'Nature' we find in natural products.

Here, however, "Nature" is not to be understood as that which is just present-at-hand, nor as the power of Nature. The wood is a forest of timber, the mountain a quarry of rock; the river is water-power, the wind is wind 'in the sails'. As the 'environment' is discovered, the 'Nature' thus

> discovered is encountered too. If its kind of Being as ready-to-hand is disregarded, this 'Nature' itself can be discovered and defined simply in its pure presence-at-hand. But when this happens, the Nature which 'stirs and strives', which assails us and enthralls us as landscape, remains hidden. The botanist's plants are not the flowers of the hedgerow; the 'source' which the geographer establishes for a river is not the 'springhead in the dale'. 185

When we are using the hammer, the hammer disappears in its use value while we are nailing boards to build a house. When we are using a hammer, we are unaware of the hammer. We are purely focused on using the hammer to accomplish a task, an intention. Heidegger tells us in this modality, the hammer disappears in use. The hammer is not present before us as a hammer but disappears in its usefulness to complete a task. When the hammer is in use, the lived space we inhabit with the hammer is the disappearance of the hammer. Rather, we are intent on the goal we intend to accomplish such as framing a house. Our lived context is the immersion in the in-order-to, to frame a house. When reality is taken in this mode its use value comes to the fore.

The negative modality of instrumentality is exhibited in the example of when the hammer breaks while in use. But if the hammer breaks and we hit our finger, we curse the hammer and our smashed finger. In this case, the lived mode we inhabit with the hammer has changed, the hammer has become conspicuous as a damn 'thing'. Now, the hammer comes to the fore as what Heidegger calls present-at-hand. Heidegger calls this lived mode of conspicuous presence where things or beings stand before us 'sitting right in front of us' as 'present-at-hand', *Vorhandenheit*. Now the hammer appears from its invisibility in use, and we inhabit the space of the hammer as showing itself as an object. It no longer disappears in use but becomes present before us. When the hammer breaks the intention to build the house recedes away as the space of

a broken hammer and a painful finger come to the fore of our contextual lived modality. Here the quality of our lived experience changes from in-order-to, e.g. frame the house, and transforms to what is simply before me, e.g. what is wrong with this stupid hammer. The quality and context of our lived experience has changed, not just what we are doing. This example shows that space is experienced as lived regionality of different contexts. Here we inhabit a different lived context or horizon in which the tool has become an object. Our lived modality of ready to hand becomes present at hand; becomes conspicuous in its failure to function as a tool. Here the value is no longer in its usefulness but in its stark presence before us. In this example, the lived mode of presence-at-hand shows itself negatively. In a positive lived modality of presence-at-hand we might think of this as the lived mode of empiricism in science. Let's also note the relativity of time and space which changes during the transition from ready-to-hand to present-at-hand.

Likewise, when we experience the being of things in the mode of use value, beings become neutral. Neutrality, 'my' historic branch hides and becomes the face of the other. The other becomes information for our use – to fortify our retreat from the face of the other. I have called this lived modality transactionalism. Transactionalism is the mode of relating to others and the environment as standing reserve, waiting to be used, *Bestand*. Heidegger thinks technology is an example of how we comport ourselves to the environment in this lived modality. In this case, the saying converted as origin to the said is pure information which comports us to the other as neutrality. Here, the light as submerged presence has calcified from chaotic intuitions of privation into sense data thought in terms of commonsense. Neutrality is the dominant modality in which modernism orients our day-to-day comportment to beings.

Note that the abstract notion of space is linear extension, e.g. feet, inches, etc., of equally divided increments. The lived

experience is much different. It is more concrete, less abstract as linear extension. The question this should bring to the fore is, “Why do we privilege abstract space over lived space?” ‘Deseverance’ is a spatial ability of *Dasein*, the ‘there’ of being, to sever regions of lived space, bringing them closer and further away. For example, when we listen to a lecturer, we are more proximally located by attention to the region of the speaker than the people sitting around us. We spatially bring the speaker closer to us than the folks around us. This lived spatiality is called deseverance. Deseverance is how Heidegger describes the way we live spatiality.

Heidegger uses the term de-severance to describe the “opening up of a space in which things can be near and far”. Consider a person wearing glasses and looking at a painting. Physically, the glasses are closer to the viewer, but for the person absorbed in the world and contemplating the painting, the painting becomes closer. The objective distances of things present-at-hand do not necessarily coincide with the remoteness and closeness of what is ready-to-hand within our lived experience. When we are listening to a lecture there is a region of the lectern and the professor which we bring closer to us than the desk we are sitting at. This region also brings with it certain social guidelines of how we comport ourselves in the space of a lecture, e.g. not obtrusive, etc. Below is how Heidegger describes deseverance,

> When we speak of deseverance as a kind of Being which Dasein has with regard to its Being-in-the-world, we do not understand by it any such thing as remoteness (or closeness) or even a distance.(1) We use the expression “deseverance”* in a signification which is both active and transitive. It stands for a constitutive state of Dasein’s Being—a state with regard to which removing something in the sense of putting it away is only a determinate factical mode. “De-severing”* amounts to making the farness vanish—that is, making the remoteness of something disappear, bringing it close.(2) Dasein is

essentially de-severant: it lets any entity be encountered close by as the entity which it is. De-severance discovers remoteness; and remoteness, like distance, is a determinate categorial characteristic of entities whose nature is not that of Dasein. De-severance*, however, is an existentiale [my comment i.e., a particularity of our existence]; this must be kept in mind. Only to the extent that entities are revealed for Dasein in their deseveredness [Entferntheit], do 'remotenesses' ["Entfernungen"] and distances with regard to other things become accessible in entities within-the-world themselves. Two points are just as little desevered from one another as two Things, for neither of these types of entity has the kind of Being which would make it capable of desevering. They merely have a measurable distance between them, which we can come across in our de-severing.

Proximally and for the most part, de-severing(3) is a circumspective [my comment i.e., contextual] bringing-close —bringing something close by, in the sense of procuring it, putting it in readiness, having it to hand. But certain ways in which entities are discovered in a purely cognitive manner also have the character of bringing them close. In Dasein there lies an essential tendency towards closeness. All the ways in which we speed things up, as we are more or less compelled to do today, push us on towards the conquest of remoteness. With the 'radio', for example, Dasein has so expanded its everyday environment that it has accomplished a de-severance of the 'world'—a de-severance which, in its meaning for Dasein, cannot yet be visualized [my comment, perhaps virtual reality brings a little more acuity]. (Heidegger, 1959, pp. 207-208)[186]

Another example of phenomenology is that of lived time. We think of time as linear, now moments equally separated as seconds, minutes, hours, etc. However, we experience time qualitatively.

When we are having fun, time flies by quickly. When we are bored, time drags on slowly. There is a varying stretch of time from a past to a future in the way we experience it. Our abstractions of time are thought of as more concrete than our experience of lived time. In "Being and Time" Heidegger writes of an inauthentic modality of lived time as a succession of 'now' moments. He writes,

> The concern which awaits, retains, and makes present, is one which 'allows itself' so much time; and it assigns itself this time concernfully, even without determining the time by any specific reckoning, and before any such reckoning has been done. Here time dates itself in one's current mode of allowing oneself time concernfully; and it does so in terms of those very matters with which one concerns oneself environmentally, and which have been disclosed in the understanding with its accompanying state-of-mind—in terms of what one does 'all day long'. The more Dasein is awaitingly absorbed in the object of its concern and forgets itself in not awaiting itself, the more does even the time which it 'allows' itself remain covered up by this way of 'allowing'. When Dasein is 'living along' in an everyday concernful manner, it just never understands itself as running along in a Continuously enduring sequence of pure 'nows'. By reason of this covering up, the time which Dasein allows itself has gaps in it, as it were. Often we do not bring a 'day' together again when we come back to the time which we have 'used'. But the time which has gaps in it does not go to pieces in this lack-of-togetherness, which is rather a mode of that temporality which has already been disclosed and stretched along ecstatically. The manner in which the time we have 'allowed' 'runs its course', and the way in which concern more or less explicitly assigns itself that time, can be properly explained as phenomena only if, on the one hand, we avoid the theoretical 'representation' of a Continuous

stream of “nows”, and if, on the other hand, the possible ways in which Dasein assigns itself time and allows itself time are to be conceived of as determined primarily in terms of how Dasein, in a manner corresponding to its current existence, ‘has’ its time.

In an earlier passage authentic and inauthentic existing have been characterized with regard to those modes of the temporalizing of temporality upon which such existing is founded. According to that characterization, the irresoluteness of inauthentic existence temporalizes itself in the mode of a making-present which does not await but forgets. He who is irresolute understands himself in terms of those very closest events and be-fallings which he encounters in such a making-present and which thrust themselves upon him in varying ways. Busily losing himself in the object of his concern, he loses his time in it too. Hence his characteristic way of talking—‘I have no time’. But just as he who exists inauthentically is constantly losing time and never ‘has’ any, the temporality of authentic existence remains distinctive in that such existence, in its resoluteness, never loses time and ‘always has time’. For the temporality of resoluteness has, with relation to its Present, the character of a moment of vision. When such a moment makes the Situation authentically present, this making-present does not itself take the lead, but is held in that future which is in the process of having-been. One’s existence in the moment of vision temporalizes itself as something that has been stretched along in a way which is fatefully whole in the sense of the authentic historical constancy of the Self. This kind of temporal existence has its time for what the Situation demands of it, and it has it ‘constantly’. But resoluteness discloses the “there” in this way only as a Situation. So if he who is resolute encounters anything that has been disclosed, he can never do so in such a way as to lose his time on it

irresolutely.

The “there” is disclosed in a way which is grounded in Dasein’s own temporality as ecstatically stretched along, and with this disclosure a ‘time’ is allotted to Dasein; only because of this can Dasein, as factically thrown, ‘take’ its time and lose it. H. 411

As something disclosed, Dasein exists factically in the way of Being with Others. It maintains itself in an intelligibility which is public and average. When the ‘now that…’ and the ‘then when…’ have been interpreted and expressed in our everyday Being with one another, they will be understood in principle, even though their dating is unequivocal only within certain limits. In the ‘most intimate’ Being-with-one-another of several people, they can say ‘now’ and say it ‘together’, though each of them gives a different date to the ‘now’ which he is saying: “now that this or that has come to pass…” The ‘now’ which anyone expresses is always said in the publicness of Being-in-the-world with one another. Thus the time which any Dasein has currently interpreted and expressed has as such already been given a public character on the basis of that Dasein’s ecstatical Being-in-the-world. In so far, then, as everyday concern understands itself in terms of the ‘world’ of its concern and takes its ‘time’, it does not know this ‘time’ as its own, but concernfully utilizes the time which ‘there is’ [“es gibt”]—the time with which “they” reckon. Indeed the publicness of ‘time’ is all the more compelling, the more explicitly factical Dasein concerns itself with time in specifically taking it into its reckoning. 187

In this rather long passage Heidegger wants to expose what he thinks is an inauthentic modality of time as living on the momentary succession of practical concern. For example, we find ourselves losing ourselves in the object of concern in order to accomplish a task which we never have enough time for, and we

lose ourselves in forgetfulness. He states this in a way which he wants to simultaneously show us that this is only one modality of time. Earlier he showed how different moods such as elation, fear, anxiety, etc. alter our lived temporality. He later goes on to show how temporality is constituent of Being and being in the world. In terms of this book, we should see a kind of relativity coming to the fore from classicism to the relativity of modernism.

Heidegger questions the arising of Being from beings. How does the lived temporality of care (*Sorge*) rise into authenticity as resolution, Heidegger criticizes the vulgar conception of time, which views it as a linear sequence of discrete "now-points." According to Heidegger, the past is the "no-longer-now," the future is the "not-yet-now," and the present flows from future to past. Additionally, he rejects any distinction between time and eternity, where temporality is derived from a non-temporal state of eternity. Heidegger contends that we are time. Temporality is not a mere external framework; it is intrinsic to our existence. The past as no-longer-now shapes our understanding of history and memory. The present as the now is where our existence unfolds. The future is the not-yet-now, revealed through anticipation. Lived time in this sense has a dynamic stretch. Temporality is not a linear progression of abstract 'now' moments; it stretches beyond mere incremental succession. Heidegger describes this as "being-ahead-of-myself-already-in-the-world." Our existence is always projected toward the future, and this anticipation defines our being. Temporality is integral to care (*Sorge*). Care involves our fundamental indebtedness and guilt, which we take over from the future. It holds together the totality of our existence, intertwining facticity, falling, and being. Heidegger's temporality of care reveals that time is not an external container but an essential aspect of our being-in-the-world. [188]

In his later works Heidegger adopts a mythopoetic style to his writing. *Ereignis* is a central concept in Heidegger's later philosophy emerging during the 1930s. *Ereignis*, often translated as the "event of appropriation". *Ereignis* refers to how being manifests itself in its

truth—a profound understanding of existence. Heidegger's writings on *Ereignis* were not initially intended for public consumption. These texts were written without didactic considerations, aiming for an originary (poietic) language—a language that might be called "experimental" or "esoteric." *Ereignis* becomes a lens through which we can explore the essence of being and its unfolding. In his later period, Heidegger's thinking undergoes another shift (though less extreme than his famous "turn"). Even during this phase, Ereignis remains significant, and its articulation deserves special consideration. Ereignis represents a profound encounter with being —an event that transcends conventional language and opens up new dimensions of understanding. 189

In his work, "Contributions to Philosophy: From Enowning", Heidegger explored the idea of self-revelation and appropriation. *Ereignis* represents a profound event where humans encounter meaningful presence and determine the meaning of their lives. Heidegger's unique way of "crafting a novel genre of philosophical writing" is characterized by an interventionist style aimed at subverting prevailing neo-Kantian thought. His focus on aesthetics extended beyond World War II, encompassing works from the 1930s to the 1950s.

The 1940s brought on Heidegger's famous 'turn', also known as "*die Kehre*", refers to a significant shift in Martin Heidegger's philosophical thought. The turn involves a reversal of perspective. Instead of focusing solely on human existence (*Dasein* – the 'there of being'), Heidegger turns toward Being itself. This shift aims to understand the fundamental nature of being beyond human consciousness. It's a move away from anthropocentrism and toward a broader consideration of existence. The turn also signifies a transformation in Heidegger's style and approach to philosophy. His later works exhibit a different tone, vocabulary, and emphasis compared to his earlier writings. Heidegger delves into historical texts, poetry, architecture, technology, and other subjects, seeking new avenues for philosophical exploration. Heidegger's concept of

aletheia (disclosure) pertains to how things in the world appear to human beings. It signifies an "unclosedness" or "unconcealedness"—a way of understanding the world. Initially, Heidegger associated *aletheia* with a redefined notion of truth, but he later corrected this association. An apophantic statement is an assertion that covers up meaning and presents something as "present-at-hand." For instance, sentences like "The President is on vacation" or "Salt is Sodium Chloride" are apophantic because they can be easily repeated in news and gossip, but the deeper context may be lost. Heidegger replaced terms like subject, object, consciousness, and world with "Being-in-the-world" (*In-der-Welt-sein*). This move transcends the traditional split between subject and object found in Western thought. Instead, Heidegger emphasizes that consciousness is always consciousness of something, and objects exist in relation to consciousness. At the most fundamental level, moods play a crucial role in our encounter with the world. A mood arises neither from the outside nor the inside; it emerges from our being-in-the-world. Only through a mood can we genuinely engage with things around us. Dasein (the 'there of being'), a term synonymous with being-in-the-world, signifies our openness to the world. It involves projecting ourselves onto possibilities, interpreting the world through those possibilities, and understanding it in terms of potentialities. Dasein is not detached from the world; it is a "thrown projection" that engages with the hidden and revealed possibilities before it. Although Heidegger rarely used the term *Kehre* himself, commentators refer to "the turn" as a significant change in his writings. Themes characterizing this turn include poetry and technology. It marks a shift in perspective—from Dasein's being to being itself—and a transformation in Heidegger's philosophical style. The most profound aspect of the turn is a fundamental change in Being's relation to us. It leads to a new inception that overcomes traditional metaphysics. By examining Being itself, Heidegger seeks to uncover its hidden dimensions and challenge conventional assumptions

about reality. The ‘turn’ in later Heidegger’s philosophy, where he shifts from a focus on human existence to a broader exploration of being and its significance. [190]

Heidegger’s ‘turn’ was based on the idea that great works of art were resolutely populist but also had revolutionary aspirations. He thought the greatest works of art “grounds history” by “allowing truth to spring forth”. [191] In Heidegger’s later writings he dispensed with the words ontic being and ontological Being all together in favor of the event of appropriation or the German word *Ereignis*. Here, the author of this journal article tells us,

> I choose to see Heidegger’s critique as anticipating the appropriation of metaphysics where his description of turning supercedes overcoming. Turning is what constitutes Ereignis, the event of being coming into its own, or what Heidegger also refers to as ‘appropriation’. Appropriation designates the moment in which the presencing of being is not taken up according to any specific determination but is allowed to presence as itself. [192]

Ereignis is German for "event" or "appropriation". The term *Ereignis* plays on its similarity to the German word "*eigen*" (meaning own or proper). Thus, *Ereignis* can be understood as the "event of appropriation". *Ereignis* involves the “revealing”, “grasping”, and “owning” of existence, allowing humans to engage with their own being and the world. *Ereignis* is not merely an event; it is the unveiling of meaningful presence that grants humans the possibility of determining any such thing as meaning. *Ereignis* transcends ordinary events; it is a “self-vibrating realm” where *Dasein* and Being intersect. Through *Ereignis*, *Dasein* and Being achieve their “active nature” by shedding the qualities attributed to them by metaphysics. It is a “dynamic encounter” that opens up possibilities for understanding existence beyond conventional boundaries.

In his book “Poetry, Language, Thought” Heidegger plays on

Heraclitus' notion of what I have been terming binary dualities with an imaginary notion of an ancient Greek temple. 193

> It is the temple-work that first joins together and simultaneously gathers around itself the unity of those paths and relations in which birth and death, disaster and blessing, victory and disgrace, endurance and decline obtain the form of destiny for human being. …The temple first gives to things their look and to humanity their outlook on themselves. 194

Ereignis is "circularity and appropriation" of "earth, sky, divinities and mortals". In a 1954 essay entitled, "Building Dwelling Thinking" in his book "Poetry, Language, Thought", Heidegger writes of his four-fold, earth, sky, divinities and mortals,

> [H]uman being consists in dwelling and, indeed, dwelling in the sense of the stay of mortals on the earth.
>
> But 'on the earth' already means 'under the sky.' Both of these also mean 'remaining before the divinities' and include a 'belonging to men's being with one another.' By a primal oneness the four—earth and sky, divinities and mortals—belong together in one. 195

Mortals represent human beings—the earthly inhabitants. They are the ones who dwell in the world, engage with it, and experience existence. Mortals are the recipients of both life and death, and their existence is intertwined with the other elements of the fourfold. The divinities are not God or gods in the traditional sense. Instead, they are hinting messengers of godhood. These entities have approached and come closer to the divine, but they are distinct from the ultimate divine presence. Their role is to reveal glimpses of the sacred and the transcendent within the mortal realm. The earthly temple of mortals gathers together the life and death of mortals and pitches to the highest aspirations of divinities.

The earth juts through world without regard to human worlding as ‘natural materials’. The earth holds a mystery which the work of art in its pure materiality and worlding as in van Gogh’s multiple paintings of a woman’s peasant shoes bring together the rich content of the paintings,

> A pair of farmer’s shoes and nothing more. And yet. [Ein Paar Bauernschuhe und nichts weiter. Und dennoch.]
>
> From out of the dark opening of the worn insides of the shoes the toilsome tread of the worker stares forth… The shoes vibrate with the silent call of the earth, its quiet gift of the ripening grain [i.e., “earth” makes “world” possible by inconspicuously giving itself to the world] and the earth’s unexplained self-refusal in the fallow desolation of the wintry field [i.e., it is also constitutive of earth that it resists this world by receding back into itself]. (Poetry, Language, Thought. 33-4, A. Hofstadter, trans. New York: Harper & Row, 1971.) 196

Heidegger pits the disclosure of the peasant women’s shoes with the earth’s refusal of disclosure in the painting’s brute materiality.

The inconspicuous thing withdraws itself from thought most stubbornly. Or can it be that this self-refusal of the mere thing, this self-contained refusal to be pushed around, belongs precisely to the essential nature of things? (Poetry, Language, Thought. 31-2, A. Hofstadter, trans. New York: Harper & Row, 1971.) 197

The Stanford article notes,

> It is worth pausing here to comment on the fact that, in his 1935 essay The Origin of the Work of Art, Heidegger writes of a conflict between earth and world. This idea may seem to sit unhappily alongside the simple oneness of the four. The essay in question is notoriously difficult, but the notion of the mystery may help. Perhaps the pivotal thought is as

> follows: Natural materials (the earth), as used in artworks, enter into intelligibility by establishing certain culturally codified meanings—a world in the sense of Being and Time. Simultaneously, however, those natural materials suggest the existence of a vast range of other possible, but to us unintelligible, meanings, by virtue of the fact that they could have been used to realize those alternative meanings. The conflict, then, turns on the way in which, in the midst of a world, the earth suggests the presence of the mystery. This is one way to hear passages such as the following: "The world, in resting upon the earth, strives to surmount it. As self-opening it cannot endure anything closed. The earth, however, as sheltering and concealing, tends always to draw the world into itself and keep it there" (Origin of the Work of Art 174). 198

As a phenomenologist Heidegger dispenses with preconceived notions inherited from the history of philosophy by seeking to concretize philosophy in lived experience. Heidegger wants to chronicle the way appropriation concretizes itself in event, the struggle to allow whatever comes of bringing to presence an essence to lived experience. So, the event of gathering appropriates in order to concretize as clearing.

> At the heart of Martin Heidegger's philosophy of being was his notion of the "clearing". The clearing is much more than just a space where something has been cleared away. It is an opening through which entities other than ourselves can emerge out of hiddenness, or are made visible by a bringing into the light. In one sense the clearing is the place or site where such unconcealment occurs, in the presence of the human form of being that Heidegger calls Dasein. In another sense Dasein is the clearing. 199

Here, we see that the temporality of presence both hides and brings to presence as clearing. For Heidegger there is one epoch which subsumes all others as the history of ‘absenting’ and ‘presenting’ of appropriating event, both as the individual subject and as lived essence.

> In Heidegger's lexicon 'being' usually designates what, in this or that historical epoch, it means for any entity to be. Hence, it is not to be confused with a term designating any entity or set of entities, though it necessarily stands in an essential relation to human beings, as creatures uniquely capable of differentiating beings from what gives them meaning. But the meaning of being, so construed, must also be distinguished from what grounds or constitutes its essential correlation with human beings. Heidegger labels this ground the Ereignis. He also refers to it as Seynsgeschichte to signal the fact that, as part of this Ereignis, the history of interpretations of being constitutes and, in that sense, underlies our way of being and understanding being. In the process, this still-unfolding history takes hold of us in the ways we make this destiny our own, mindlessly or not. Indeed, in our preoccupation with particular beings (including the metaphysical preoccupation with them insofar as they exist, i.e., with the being of beings), this history easily escapes our notice. 200

As embodied encounter of the other, the other in transactionalism disappears in use value. When history as presence is shown in pre-understandings of ‘common sense’, the submergence of histories as possible ways of being-in-the-world is forgotten as ‘common sense’, as a different kind of presence, it is in the mode of what Heidegger calls circumspection (*Umsicht*).

Circumspection can refer to our practical, unreflective engagement with the world. Circumspection can be inauthentic or

authentic. In inauthentic circumspection, we navigate life without deep introspection or awareness. Inauthentic circumspection involves a kind of prudent foresight—we act based on habit, social norms, and practical considerations. It's a mode of existence where we blend into the collective, following societal conventions and norms. Inauthentic circumspection characterizes our everyday, mundane interactions with the world. Here, we lose sight of our individuality. We become part of the "they," the anonymous crowd, and conform to societal expectations. Our actions lack depth, and we remain dispersed into the neutrality of the world and existence. For Heidegger, authentic circumspection involves a profound self-awareness. It's the recognition of our unique existence, our *Dasein* (being-there). Authenticity requires facing existential realities: mortality, anxiety, and conscience. When we confront these moments head-on, we transcend mere inauthentic circumspection. Authentic existence emerges when we embrace our individuality, acknowledge our finitude, and make choices aligned with our true selves. [201]

A similar idea to authentic circumspection was thought of by Heidegger's mentor Edmund Husserl as a 'phenomenological reduction' of epoché, or bracketing assumptions made by what Heidegger may have referred to as inauthentic circumspection. Husserl referred to this as "*phenomenological reduction*".

> This deep-structure of intentional consciousness comes to light in the course of what Husserl calls the "phenomenological reduction" (Husserliana, vol. XIII, pp. 432 ff), which uses the method of epoché in order to make coherent sense, in terms of the essential horizon-structure of consciousness, of the transcendence of objective reality. The most global form of epoché is employed when this reality in total is bracketed. There is still something left at this point, though, which must not, and cannot, be bracketed: the temporal flow of one's "present" experience, constituted by

> current retentions and original impressions. These recurrent temporal features of the horizon-structure of consciousness cannot be meaningfully doubted. They provide a kind of hýle for "inner perception" and corresponding reflective judgements, but it is a very special kind of hýle: one that is a proper part of the "perceived" item and does not get conceptually "formed" in the course of perception (reflecting the fact that unlike spatio-temporal objects, lived experiences "do not adumbrate themselves"; cf. Husserliana, vol. III/1, p. 88). Hence, there is no epistemically problematic gap between experience and object in this case, which therefore provides an adequate starting point for the phenomenological reduction, that may now proceed further by using holistic justification strategies. After all, intentional consciousness has now been shown to be coherently structured at its phenomenologically deepest level. [202]

In dismantling vague preconceptions and assumptions, Husserl thinks we can start again from rudimentary raw materials (*hýle)* in order to reconstruct our circumspectual comportment to intentional consciousness more authentically. For Husserl in this nexus of physics and philosophy, we stand at the door of another possibility – a new epoch [related to Greek *epoché*].[203] This paper tells us that our word epoch came from the Greek word *epoché* which…

> inferred the need for total suspension of judgment (epoché) on things." … "Epoché (ἐποχή, epokhē "suspension") is an ancient Greek term which, in its philosophical usage, describes the theoretical moment where all judgments about the existence of the external world, and consequently all action in the world, is suspended.[204]

Our English word 'epoch' denotes a fixed point of time, an age or a long duration of time. We use the word as demarcated by some

common era such as age of Enlightenment, classical or modern age, etc. In Husserl's foundational work "Logical Investigations" (1900-1901) Husserlian scholars have argued that he may have used the ambivalence of *epoché* and epoch to imply that the phenomenological reduction would usher in a new epoch where science would lose the primacy of its historic abstractions and found itself on principles which go back to the things themselves, how we intentionally experience things. [205] It is interesting that Husserl's intuitions only prefigured Einstein's work in special relativity and eventually quantum entanglement by only a few years. The storm clouds signaling the end of modernism's supremacy were gathering.

However, in all this one fact of history interrupts Heidegger's work – the violence of Nazism.

> Heidegger joined the Nazi Party (NSDAP) on May 1, 1933, ten days after being elected Rector of the University of Freiburg. A year later, in April 1934, he resigned the Rectorship and stopped taking part in Nazi Party meetings, but remained a member of the Nazi Party until its dismantling at the end of World War II. The denazification hearings immediately after World War II led to Heidegger's dismissal from Freiburg, banning him from teaching. In 1949, after several years of investigation, the French military finally classified Heidegger as a Mitläufer[1] or "fellow traveller."[2] The teaching ban was lifted in 1951, and Heidegger was granted emeritus status in 1953, but he was never allowed to resume his philosophy chairmanship. [206]

Edmund Gustav Albrecht Husserl was born into a Jewish family in Prostějov (Prossnitz), Moravia, which was part of the Austrian Empire at the time. Although he had converted to Protestantism in his youth, the Nazi regime classified him as a Jew. As a result, he faced discrimination, was deprived of many honors, and was

expelled from the library of the University of Freiburg due to his Jewish background. Despite these challenges, Husserl's groundbreaking work in phenomenology profoundly influenced 20th-century philosophy and continues to resonate in contemporary thought. Heidegger, who acknowledged his debt to Husserl, later took a political stance that was offensive to Husserl after the Nazis came to power. Heidegger, infamously a Nazi proponent, was himself of Jewish origin. 207

Levinas, a Lithuanian Jew, became a naturalized French citizen in 1931. He fought with the French and was captured by the Nazis where he remained a prisoner of war until the end of the war in 1945. His father and brothers died at the hands of the Nazi SS in Lithuania. Maurice Blanchot helped Levinas' wife and daughter spend the war in a monastery (Emm). Both men understood the horror of war and made brilliant strides to wrestle with the absolute need for meaning in what appeared to be a meaningless world. They both described in very different ways the pitfalls of humanity and articulated with painful integrity and brilliance an avenue of hope in a hopeless world. Levinas is not so easy to pin down with a political philosophy. Levinas warns us of the insidious nature of totalitarianism. In this way, his forebodings about the state have a kinship to Orwell's critique of nationalism.

In 1988, Levinas wrote an article titled "As If Consenting to Horror," where he revealed that he learned early, perhaps even before 1933, about Heidegger's sympathy toward National Socialism (Nazism). This insight sheds light on the complex relationship between Heidegger's philosophy and his political inclinations. While Levinas criticized Heidegger's ontology, he also acknowledged that Heidegger's reflections on death led him to view *Dasein* (human existence) as anti-social rather than overly immersed in the socio-historical context. 208

The dance of philosophy and physics continued in phenomenology and relativistic physics. Physics relativized absolutes of classical physics while concurrently, phenomenology relativized absolutes of classical philosophy. In relativity space and time are relative to the speed of light. Space and time can be twisted and distorted in extreme fashions in which absolutes like extension and linear clock time can no longer be 'real' but are subjected to 'actual' distortions by the speed of light. Relativity informs us that 'reality' is relative to the frame of the observer. Therefore, classical scientific absolutes are 'absolutely' relative. However, relativity still could be said to posit an absolute as the speed of light. If it were not for quantum physics which does not recognize temporality at all e.g., quantum entanglement, relativity might indeed be yet another rehash of the classical absolute in terms of the speed of light. Similarly, phenomenology wants to get away from classical abstractions about spatiality and temporality by, for example, relativizing them to lived regions and lived temporality. The old idea that relativity and phenomenology would simply make everything subjective no longer finds relevance in the 20th century. The reactionary push back to 20th century neo-physics and neo-philosophy came from 'institutionalists of the previous era of physics and philosophy. In the early to middle 20th century the overwhelming evidence in relativistic physics and the appeal to concrete lived experience of space and time won out over modernist notions of subjectivity. But what happened in this dynamic reappraisal of language and meaning was nothing new to history and classicism.

Attention to the future, the yet to be determined, places a requirement that tired old truisms must renew themselves. Science has an advantage over philosophy in that mathematics can largely escape the emotive investment of historic terms in language. However, philosophy must work in terms of historic languages. Classical philosophy takes the route of endlessly assigning new and more adaptive meanings to previous ideas. This is also the reason that philosophy tends to be relegated more easily to the ethereal

junk yard of absurdity in common perceptions. However, both science and philosophy must be true to the future no matter what the reactionary push back might be. This book has brought to the fore examples of religion bogged down in meanings of the past, tradition, and institutional conservatism. But this happens in secular history as well. However, neither can resist necessities imposed by the future. In science, mathematics allows a kind of unencumbered freedom to strike out in radically new directions. However, even mathematics is rewarded economically when new mathematics can assimilate or explain the dominant mathematics of its day. In spite of this, the most pervasive revolutions in the history of science tend to be represented by the adventurers who threw all caution to the wind, e.g., Einstein. Certainly, the contemporaneous budding of phenomenology was also a revolutionary step which made previous histories abstract and less concrete. But before phenomenology there was Hegel.

In the 19th century Hegel was caricatured in his day as an 'idealist'. Idealism in that sense carried with it the intonations of subjective, not objective. Again, the binary dualisms of history's narration and search for a continuum of meaning pressed on from the past. But Hegel recognized the failure of classicism which preceded him. Hegel understood that the problem was not so much with language but the assignment of meanings to the language. This was quite insightful and also in keeping with the scientific discoveries of his day, e.g., evolution, germ theory of disease, periodic table of elements, electromagnetism, thermodynamics, major advances in spectral analysis leading to electromagnetic fields, X-rays, and radioactive elements, and in mathematics complex variables gave rise to new geometries, series convergences, and hypercomplex numbers and let's not forget the new mathematics gave way to the more concrete embodiment of the atom.

In the 19th century Hegel saw all these scientific massive changes. He also understood how these very important

breakthroughs also rhymed with more repressed echoes from the past. Hegel understood that commonly accepted definitions and meanings of language were not fundamentally static but dynamic. The problem with language and classicism was that it tried to force meanings into essential static forms. Hegel called these static forms of language ‘abstract’. Hegel, ahead of his time, understood that abstract meanings, meanings which had lost the day in history, were the problem. The answer as in science was to radically change the way we understood common vernacular. Hegel determined that logical contradictions were not absolutes but semantic vehicles for phenomenology. In other words, contradictions need not end in absolute dualities like Descartes' mind-body or Kant’s categories of understanding and the impenetrable thing-in-itself but could find more concrete meanings by transformation. By ‘transformations’ I mean undermining abstract and conservative trends for static binary dualisms. Hegel found in historically muted echoes of Leibniz the idea that all predicates are contained within the subject. The clearest and also hardest to understand example of this is Hegel’s radical approach to the meaning of ‘concept’.

Classical logic was dominated by noncontradiction as the exclusive right of epistemology or truth. Hegel’s logic nurtured contradiction in transformation. For Hegel, Concept was not our abstract semantic of a thought, an idea, which takes place in the ‘mind’ of a subject, and which fermented into the mid/body split of Hegel’s predecessors. Concept through a process of dialectical transformations was built in *phusis* organically in a similar way in which we think of biology, or what *is*. The previously assumed classical notion of *is* was the problem. The reactionaries wanted to reduce Concept in Hegel to ‘idealism’ but the power of Hegel’s thinking eventually turned the momentum of history towards another shore, a future in which absolute time and space could be made relative, lived time and space could find meaning without being ‘idealized’ as mere subjectivity. It may also be argued that Hegel’s philosophy aided communism and perhaps some versions of

nationalist fascism (although that is very problematic in his writings of the state). However, Hegelians would argue these critiques as a demented form of Hegelianism. But in terms of dialectical materialism and leftist schools of Hegel, the historic record of communism in Karl Marx was an explicit outgrowth from Hegelian philosophy. Additionally, even today there are many leftest Hegelian schools of Christian dogma which adhere to the teachings of Hegel e.g., Hegelian Catholic schools. The leftest schools take Hegel's notion of Concept into a theological framework. There are also more centrist schools of Hegel which focus on Hegel's dialectic in the Logic, the "Science of Logic". Hegel is one example of how philosophy in the 19th century danced with major transformations in science heeding the emptying out of that period's contemporaneous tiring of the 'same ol' song' in previous classical language. Once again, the future beckoned.

The early Heidegger in "Being and Time", somewhat akin to Hegel's Concept, tried to think about Being in a phenomenological novel fashion. And just as Hegel's Concept was superficially criticized as 'ideal' so Heidegger's notion of Being was superficially criticized as what Heidegger termed 'onto-theological'. By 'onto-theological' Heidegger was referring to the tendency to make 'Being' into a kind of substance (onto) or thing separate from beings, from us. Likewise, Heidegger's early work was not an effort to reiterate the history of Being in terms of a god-like notion of Being. Heidegger, like Hegel, wanted to find a more organic relationship to beings, to us, in the very elusive and taken-for-granted notion we have Being. And also, like Hegel, Heidegger's novel and complex notion involved a radical rethinking of what we can possibly mean by our hazy idea of Being. The tendency to take an onto-theological approach to Heidegger's notion of Being was a partial reason for Heidegger giving up his use of the term 'Being' altogether in his latter writings. Instead, Heidegger's 'turn' went towards a more mythopoetic style and his notion of the German word '*Ereignis*'. *Ereignis* in German has the idea of an 'event of

appropriation'. Again, *Ereignis* is a very technical term not appropriate for this book. But perhaps the idea might have some interesting analogical intonations to what I have discussed concerning branching, falling, collapsing into classicism from the observer effect of the wave function. In any case, in Heidegger's early writings some have taken the notion of Being as a more novel approach to intuitions from classicism.

This general approach may also have some superficial similarities to what Hegel did with his notion of Concept. From a general technique perspective, perhaps similar to finding more relevant reassignments of meanings from classicism's worn-out ideas of concept, being, and constituents of existence. The early Heidegger and Hegel follow a tendency to reappropriate classically understood terms in novel and more nuanced and relevant ways. However, It seems to me that these techniques have an analogical similarity not unlike classical chaos theory which tries to maintain classical notions of causality by reassigning causality to asymptotic infinitesimals. However, the inability of this type of undertaking still cannot face the bizarre philosophical implications of quantum chaos theory. To be fair, it is arguable that in my understanding both Hegel and Heidegger still had not reckoned with the extreme ramifications of the void which faces us in quantum chaos and radical externality. It is also arguable that this kind of refitting classicism from worn out meaning-bestowing aspects of historic language implicitly takes on a kind of backseat approach to responsibility and ethics. Mine and Levinas' contention is that the reckoning of the abyss we face in the radical externality cannot find a home in the incessant wearing out and ever more reassigning of novel ontological and epistemological classical notions. These techniques provide a pseudo-ethical basis for responsibility to the other which always seem to get reappropriated in terms of force and violence. In any case, certainly Hegel and Heidegger were not the first re-interpreters of classicism. Progressive classicism entertains an ever more linguistic refitting to rescue the lagging

meaning bestowing ability of language.

Classicism itself was permeated with revolutions in science and math all throughout its history. However, the institutionalized momentum of tradition and commonsense in popular culture was always a dampening effect to change and transformations. Our classical past, our 'nature', wants to sterilize the future, find meaning which links the past to the future. I call this meaning-bestowing. This dynamic continues to this day. Eventually the future presses on to upcoming generations, making change and transformations inevitable. History is the flow of past and future, reactionaries and revolutionaries. More concerning, all the while classicism retains the signature of force and violence throughout its course, underscoring a more pervasive and dominant theme at any cost – the perception and appeal of continuity.

All major shifts in scientific or philosophical paradigms must eventually be recaptured by narrative. Language must ready itself to accommodate extreme shifts which are forward looking. History is the accommodation of continuity. Continuity desires origin. Origin is the guarantee of meaning for classicism. The desire for classicism is the quest for meaning. Meaninglessness is not an option for species survival. The binary duality of meaning and meaninglessness forces continuity as history and narrative. Is there an exterior to this desire to conserve, retain, find meaning in binary dualisms? This is the question which looms before us now. In the 20th century, the last vestiges of classicism hang on in phenomenology. As I will soon discuss, postmodern philosophy is intently and painfully aware of our inability to be able; to find yet another classical hope for a novel refitting of philosophy to unbridgeable exteriority. Likewise, the last vestiges of classicism hang on in relativity. In spite of the most successful physics in human history, underneath relativity we find a troublesome void. In quantum chaos theory physics faces a spooky chasm papered over in the veneer of complementarity.

Quantum physics finds no home in the past. Certainly, the desire

of quantum physicists to maintain continuity with relativity is, to a degree, found in the successes of quantum field theory. But even that is no done deal in spite of vigorous work to make it so. Bohr's desire for complementary relations between quantum physics and classical science attempts continuity with classical physics as a limited case of quantum physics. As such, it has drawn much attention and funding from working physicists who have practical concerns about their own livelihood. But even they are fully aware of the radical rupture quantum physics brings to the fore which vastly exceeds complementary aspirations. This book has been an effort to bring quantum physics' implications out of mathematics and into the purview of those of us who cannot be conversant in the highly specialized language of quantum mathematics. And I am not the only one to attempt this. As I have detailed, the greatest, and to this day, even the not so well-known geniuses of quantum physics well understand its radical implications. They wrote unapologetically about it in philosophical terms. Quantum physics really is a radical departure from history, our collective narratives. Language does not easily or novelly accommodate the abyss which looms in quantum physics. We cannot easily adapt meanings to its findings. This is not because of its admitted difficulty for non-mathematical folks but because of the awkwardness and inability for language to bring it to 'sense', to reawaken it once again to history's narrative.

Quantum physics represents a gap which makes it difficult to find words. Perhaps it is better to feel its effect as an unbridgeable gap. I believe we see this affective dis-ease in the forebodings of fanatical and extremist anti-woke reactionaries. This radical disruption of history can find no revolutionaries. We are venturing beyond the domain of narrative which cannot resurrect classical notions as postmodernism demonstrates. I find in the philosophy of Levinas, similar to quantum physics, a radical departure from classicism and its perennial offspring. Both physics and philosophy bring us to an abyss which cannot be bridged by novel and rigorous

shifts in meaning and definition. Both leave us speechless, unable to be able. However, what quantum physics cannot capture, Levinas brings before our face – responsibility.

The radical rupture of quantum physics is not some concept which can be fashioned from the scrap pile of history. Rather, quantum physics brings us to an abyss, chaos, which finds no dominant home in history. Furthermore, in Levinas we are not merely left dangling without recourse as in quantum physics. Levinas brings us face to face with the other. The other here is not my assumed, comfortable, and meaning-bestowing certainties from language and history. The other here is he, she, or binary gender ambivalences who not only contest us but call us to responsibility. There is no home in Levinas' radical alterity of the other. Our inability to even be able in the radical alterity of the other is whom history retreats. More importantly we, me, self, as the constitution of isness is itself retreat. There is no underlying basis to mine-ness. Mine-ness retreating from radical alterity becomes 'me', a self (might we think analogically branching from the observer effect?). Mine-ness as falling away from classical re-foundationalism has no recourse to classical novelty before unbridgeable interruption. Mine-ness only makes possible echo and transactionalism and even the very basis of commonsense. Commonsense assures, assumes, and is rooted in the mystical incantation of 'I am that I am'. In the face of radical alterity, the self is created as retreat. The self as retreat finds mytho-metaphysical 'reality' in its attempt to flee radical externality. In the drying up of classical novelty the pitched desperation of terror is the end of the very possibility of classically fueled, meaning-bestowing ability. This is the horror of death. Death twists and distorts mythopoetic intuitions of radical externality in which the 'my' of origin finds no home. More on that later. For now, I want to take a deeper look into postmodernism and other attempts reckoning with unrecoverable devastations to classicism in the 20th century.

Structuralism

In the lead up to postmodernism in the 20th century, the heir of existentialism was called structuralism. [209] Existentialism was a philosophical movement, dominant in Europe during the 1940s and 1950s which emphasized individual experience, choice, freedom, and responsibility. Existentialists, led by thinkers like Jean-Paul Sartre (1905-1980), maintained the primacy of lived experience. Interestingly, existentialism made contributions to structuralism and furthered both poststructuralism and hermeneutics.

> The most popular voices of this movement were French, most notably Jean-Paul Sartre and Simone de Beauvoir [1908-1986]], as well as compatriots such as Albert Camus [1913-1960], Gabriel Marcel [1889-1973], and Maurice Merleau-Ponty [1908-1961], the conceptual groundwork of the movement was laid much earlier in the nineteenth century by pioneers like Søren Kierkegaard [1813-1855] and Friedrich Nietzsche [1844-1900] and twentieth-century German philosophers like Edmund Husserl [1859-1938], Martin Heidegger [1889-1976], and Karl Jaspers [1883-1969] as well as prominent Spanish intellectuals José Ortega y Gasset [1883-1955] and Miguel de Unamuno [1864-1936]. [210]

Structuralism emerged as an intellectual current and methodological approach primarily in the social sciences. It interprets elements of human culture by examining their relationship to a broader system. In essence, structuralism seeks to uncover the underlying structural patterns that shape human actions, thoughts, perceptions, and emotions. Philosopher Simon Blackburn succinctly captures this idea: “The belief that phenomena of human life are not intelligible except through their interrelations. These relations constitute a structure, and behind local variations in the surface phenomena, there are constant laws of abstract

structure".

Structuralism was influential in various fields, including linguistics, anthropology, and literary theory. Structuralists believed that underlying structures (such as language, culture, or society) shape human experience and meaning. They focused on binary oppositions, patterns, and deep structures. Structuralism was criticized for its rigidity and tendency to oversimplify complex phenomena. It often ignored historical context and individual agency.

The roots of structuralism can be traced back to early 20th-century Europe, particularly in France and the Russian Empire. Structuralism goes back to Ferdinand de Saussure (1857-1913) who developed a theory of structural linguistics. Wilhelm Wundt, a German psychologist, is often considered one of the founders of structuralism. He established the first psychology laboratory in Leipzig, Germany, in 1879. Edward B. Titchener, a student of Wundt, further developed structuralism in psychology. He introduced it to the United States and emphasized introspection as a method for understanding mental processes. In psychology, structuralism aimed to break down mental experiences into their basic components (such as sensations, feelings, and thoughts). Researchers used introspection to analyze conscious experiences. Structural linguistics, influenced by Swiss linguist Ferdinand de Saussure, focused on the underlying structure of language. Saussure introduced the concepts of "langue" (the abstract system of language) and "parole" (actual speech). Structuralism influenced these fields by examining cultural practices, rituals, and social institutions as interconnected systems.

Psychology emphasized introspection. In psychology, participants were asked to describe their conscious experiences (such as sensations or emotions) in detail. Researchers aimed to identify recurring patterns. Structuralists analyzed elements by contrasting them with their binary opposites (e.g., light vs. dark, male vs. female, etc.). Language analysis was important to

structuralists. Saussure's approach involved studying linguistic signs (signifier and signified) and their relationships within a language system.

Prominent structuralists include Ferdinand de Saussure and Claude Lévi-Strauss. Structuralism gained prominence through the structural linguistics work of Ferdinand de Saussure and subsequent schools in Prague, Moscow, and Copenhagen. Interestingly, structuralism inherited some of its intellectual momentum from existentialism. After World War II, scholars across various disciplines adopted Saussure's concepts, including French anthropologist Claude Lévi-Strauss, who played a pivotal role in popularizing structuralism. Linguist Roman Jakobson and psychoanalyst Jacques Lacan were also prominent figures associated with this movement.

Critics argued that introspection was subjective and unreliable. Additionally, structuralism focused too narrowly on conscious experiences. The rise of functionalism (which emphasized the purpose and function of mental processes) led to a decline in structuralism's popularity. Despite its decline, structuralism laid the groundwork for later developments in psychology, linguistics, and cultural studies. Concepts like binary oppositions and the study of underlying structures continue to influence various disciplines. Structuralism sought to uncover the fundamental building blocks of human experience and culture, emphasizing systematic analysis and interconnections. 211

Saussure argued that there is a difference between an idealized abstraction of language he called *langue* and language actually used in daily life he called *parole*. 212 *Langue*, abstract 'meanings' we ascribe to words we actually use, *parole*, have no 'meaning' if by 'meaning' we assume they inform us of concepts which are immanent externalities to language. By immanent externalities I mean something which gives our concepts a direct meaning and validity based on an assumed externality like our word 'reality'. For structuralism the notion of immanent meaning was a kind of

metaphysic imagined as immanent, as the direct embodiment of an idea. For Saussure our words have no sense of meaning like this. Instead, words are merely signs which point to signifiers, syntax which points to semantic. Saussure tells us that since many different words can apply to the same object or concept, words exhibit a system of signs which endlessly refer to other signs. The sign only has meaning in relationship to the other signs to which it points. Saussure tells us, "…*in language, there are only differences 'without positive terms*'" 213

Many thinkers in diverse areas such as anthropology, sociology, psychology, literary criticism, economics, and architecture have utilized Saussure's methodology in very interesting ways. This approach to language and philosophy is synchronic meaning how it is used in the present moment without resorting to history, a temporality. This is contrasted to diachronic which refers to a history, a progression through time. If language is purely relational it is synchronic meaning it refers to nothing other than itself. If it is diachronic language brings with it a history of ideas which finds some meaning in normal usage. Saussure's metaphor was to imagine language as a series of static points (like frames in a film), each representing a specific stage. The film is a diachronic account of language. But language change occurs between these static points as synchronic. It is interesting that physics has a similar situation between general relativity and quantum mechanics.

While existentialism and structuralism have distinct emphases, they intersected in intellectual history. Structuralism rose to prominence in France following the existentialist wave, particularly during the 1960s. The initial popularity of structuralism in France led to its global influence, offering a unified approach to understanding human life across various fields such as anthropology, sociology, psychology, literary criticism, economics, and architecture. Although existentialism and structuralism diverged in focus, their intertwined legacy continues to shape contemporary thought. 214

In non-relativistic quantum mechanics, time is regarded as universal and absolute. By using the terms ‘universal’ and ‘absolute’ quantum physics does not mean it gives some sort of ‘physical’ meaning to time. The use in quantum physics means it is simply used as a classic background parameter which is external to the system itself and merely a utilitarian tool for research and experimentation. It is more like snapshots in a film where we have one state here and another here and physics asks what, if any, is the relation between the states. Or in other words, what are the synchronic changes. The notion of ‘time’ and history in this case is more like frames in the film or diachronic. However, the synchronic change or lack of change is more interesting as it is purely relational and does not try to investigate for example what time ‘actually is’. In thinking of time as universal and absolute there is no philosophical importance attached to the concept of time itself. In early science and philosophy time was believed to be an actual phenomenon based in ‘reality’. But modern science realized that time had no basis in anything ‘absolute’ but was stochastic or statistical, discontinuous, quantum ‘jumps’ between observed stationary states. In the time dependent Schrödinger wave equation time dependence is only understood in superposition as a relationship between quantum wave interference states. This is called perturbation theory or how things react when they are perturbed. In contrast, the observables which means collapse or branching into classical physics is not a continuum of time into classicism but a rupture, kinematic meaning simply mechanical points without any association to forces, motions, or continuums which might link to points. What we think of as historical time, diachronous time, is not at all the common classical notion we have of time as some sort of glue between, causal relation between, two states. Like structuralism which thinks of language as purely relational, quantum physics thinks of spacetime as stochastic, totally separate statistical, states with no on-going relation or history filling the gap that unifies and makes continuous like our

common notion of time. 215 If you saw the recent movie "Everything Everywhere All at Once" that is the idea in quantum mechanics.

However, in general relativity, time is considered continuous, malleable, and relative. Quantum mechanics regards time as an independent variable, not a meaningful factor in the phenomenon it studies. As an independent variable it is discontinuous, utilitarian, where differences of state are purely referential and synchronic. This chasm creates a conceptual conflict between quantum physics and general relativity, known as the problem of time. The problem of time raises questions about the nature of time in a physical sense and whether it is truly a real, distinct phenomenon. It also involves the related question of why time seems to flow in a single direction, despite the fact that no known physical laws at the microscopic level seem to require a single direction. The problem of time arises from this conceptual conflict between the two theories and raises questions about the nature of time in a physical sense. So, for structuralism time is not like general relativity or evolutionary. It is interesting to note that Aristotle was more synchronic than diachronic.

Postmodernism

Postmodernism is an intellectual stance or mode of discourse characterized by skepticism towards elements of the Enlightenment worldview. In the 1940s postmodernism really began to address the abstractions of modernism and the relativistic trend of phenomenology to found dominant themes emerging from lived experience. At its height, postmodernism generally ranges from 1970 to 1990. Postmodernism questions the "grand narratives" of modernity, which include Enlightenment ideals such as reason, science, and progress. It rejects the certainty of knowledge and stable meaning, acknowledging that ideology plays a role in maintaining political power. It acknowledges the influence of

ideology in maintaining political power. Postmodernism embraces self-referentiality, epistemological relativism, moral relativism, pluralism, irony, irreverence, and eclecticism. It opposes the "universal validity" of binary oppositions, stable identity, hierarchy, and categorization. Emerging in the mid-twentieth century as a reaction against modernism, postmodernism has permeated various disciplines and is linked to critical theory, deconstruction, and post-structuralism. Critics argue that postmodernism promotes obscurantism, abandons Enlightenment's rationalism and scientific rigor, and contributes little to analytical or empirical knowledge. [216]

Postmodernism is a multifaceted artistic movement that emerged in the mid-20th century as a reaction against the modernist ethos. Postmodernism is interested in conceptual art. Conceptual artists shifted the focus from the physical object to the idea behind it. They explored concepts, language, and context, often challenging traditional artistic forms. Postmodernism values minimalism. Minimalists embraced simplicity, reducing art to its essential elements. Their works featured clean lines, geometric shapes, and a sense of austerity. Postmodern artists harnessed video technology to create dynamic and time-based artworks. Video art challenged traditional notions of static visual representation. Performance art arises from postmodernism as performers engaged with their bodies, time, and space to create live, ephemeral art experiences. These performances often blurred the boundaries between art and life. Postmodernism is critical of institutions. Artists critiqued art institutions, questioning their authority and power structures. They explored how museums, galleries, and curatorial practices shape artistic meaning. Postmodernism questions identity. Postmodernism emphasized diverse identities and perspectives. Feminist art, LGBTQ+ art, and art by marginalized communities challenged dominant narratives. Postmodernism embraced irony, humor, and playfulness. Artists subverted conventions, creating fragmented and self-referential

works. Postmodernists blurred distinctions between high art (traditionally associated with elite culture) and low art (popular culture). Elements from mass media, advertising, and consumer culture found their way into artworks. Postmodernism critically analyzes authenticity and originality. Postmodernism questioned the idea of a single, inherent meaning in art. Viewers became active participants, shaping interpretations. Concepts like appropriation and ready-mades challenged notions of authenticity. Postmodernists rejected grand narratives and embraced the local, contingent, and temporary. They resisted totalizing theories and celebrated diversity.

Postmodernism is a broader cultural and artistic movement that emerged in the late 20th century. Postmodernism rejects absolute truths, celebrates diversity, and challenges authority. It questions metanarratives (universal explanations) and embraces hybridity. Irony, intertextuality, and pastiche characterize postmodern works. Postmodernism draws from post-structuralist ideas. Both emphasize language, subjectivity, and the constructed nature of reality. Postmodernism extends beyond academia to influence architecture, literature, film, and popular culture. In summary, while structuralism laid the groundwork, post-structuralism critiqued and expanded upon it. Postmodernism, in turn, absorbed elements from both, creating a rich tapestry of thought and creativity. 217

Poststructuralism

Poststructuralism is a philosophical movement that emerged in France during the late 1960s. It challenges the objectivity and stability of the interpretive structures proposed by structuralism. Unlike structuralism, which posits that human culture can be understood through a structure modeled on language, poststructuralism asserts that these structures are constituted by broader systems of power. In particular, it finds systems of power that organize themselves around a narrative of binary oppositions.

As we saw with Hegel binary oppositions were necessary at every step along the way with the added difference that binary oppositions gave way to higher binary opposition which unified hierarchically lower binary oppositions which gave rise to higher unities. Even absolute spirit had to 'not' itself to earn the ultimate title - 'absolute'.

Post-structuralism emerged as a critical response to structuralism. It gained prominence in the 1960s and 1970s. Post-structuralists rejected the idea of fixed, universal structures. They emphasized the role of language, discourse, and power in shaping meaning. Jacques Derrida, Michel Foucault, and Roland Barthes are notable post-structuralist thinkers. Post-structuralists questioned binary oppositions and sought to deconstruct them. They highlighted the instability of meaning and the impossibility of pure objectivity. Context, contingency, and subjectivity became central concerns. Post-structuralism blurred boundaries between disciplines. Post-structuralism is a precursor to postmodernism. While not identical, they share themes like skepticism toward grand narratives, playfulness, and a focus on representation. Post-structuralism influenced postmodern art, literature, and philosophy.

Poststructuralists critique the binary oppositions that form the basis of structuralist structures. They reject the idea that media or the world can be interpreted within pre-established, socially constructed frameworks. Structures require a kind of self-sufficiency, a unifying and organizing sameness to qualify as 'structure'. Poststructuralism discards the notion that structuralist definitions of signs are both valid and fixed. It questions the assumption that authors employing structuralist theory are somehow above and apart from the structures they describe. Notable figures associated with poststructuralism include Roland Barthes, Jacques Lacan, Julia Kristeva, and Michel Foucault. Poststructuralism challenges the rigidity of structuralist thinking and emphasizes the role of power dynamics in shaping meaning and interpretation.

Structuralism, simply put, was based on the idea that language is purely relational and built up from a system or structure layer upon layer, syntax upon syntax, sign upon sign which points to nothing other than the dynamics of the structure. This is synchronic. Poststructuralism began to question these assumptions. Poststructuralism criticized the notions of signs as a definite pointer to other signs. Signs do not build up a structure layer upon layer, a synchronic center. There never is a meaningful structure extant from the arbitrary and random play of signs pointing to signifiers which always point to other signs. Signs do not always point consistently to another sign which conforms to a linguistic structure. The whole notion of 'structure' cannot substantiate itself from the random play and lack of consistency within any particular sign. Poststructuralism then gives way to deconstruction. 218

Deconstruction

Deconstruction is a term that has different meanings in different contexts. In philosophy and literary criticism, deconstruction is a method of analysis that challenges the assumptions and oppositions that underlie Western thought. It was developed by the French philosopher Jacques Derrida and his followers. Deconstruction examines how language, logic, and meaning are constructed and destabilized by texts. In art, architecture, and design, deconstruction is a style or movement that breaks down conventional forms and structures into fragmented and distorted elements. It often creates a sense of disorientation, complexity, and unpredictability. Some examples of deconstructivist artists and architects are Pablo Picasso, Marcel Duchamp, Frank Gehry, and Zaha Hadid. In building and construction, deconstruction is the process of dismantling a structure in a way that preserves and reuses its components, rather than demolishing it and sending it to landfills. Deconstruction is considered a more environmentally friendly and cost-effective alternative to demolition. It also reduces

waste, saves energy, and creates jobs.

In deconstruction within any system of signs, any system must always and necessarily deconstruct any structure from within its own terms. The endless and random play of signs must undo itself any notion of structure. It de-centers itself of its own accord. Deconstruction wants to show that any system must necessarily imply its own negation. Any structure necessarily implies its own deconstruction by its own terms e.g., without any external negation but in its own hidden and suppressed affirmative declarations (margins of the text). Any systemic organization cannot help but undo itself. This brings me back to the problem I have referred to as binary dualisms. At the center of binary dualisms is logic itself. 219

Deconstruction is a philosophical and critical method introduced by the French philosopher Jacques Derrida. It challenges traditional notions of meaning, hierarchy, and stability within texts and language. Deconstruction examines the relationship between text and meaning. It questions the idea of fixed, absolute truths and instead focuses on the fluidity and complexity of interpretation. Jacques Derrida's influential work, including his book Of Grammatology, laid the foundation for deconstruction. He emphasized that meaning arises from contrasts between signs and words, rather than from self-sufficient definitions. Derrida drew inspiration from linguist Ferdinand de Saussure. He argued that language gains meaning through the tension between opposing terms. For example, the word "being" only makes sense in contrast to "nothing." Meaning is deferred, never directly present. Deconstruction seeks to identify and overturn hierarchical oppositions within texts. These include signified over signifier, intelligible over sensible, speech over writing, and activity over passivity. However, deconstruction doesn't aim to eliminate all oppositions; they are structurally necessary for creating meaning. Deconstruction challenged fixed meanings, revealing the complexities inherent in language and thought. It has influenced fields such as philosophy, literary criticism, and social sciences. 220

Let's tie this back to what was happening in physics around the same time as Husserl and Heidegger were describing lived time and lived space. Leonard Susskind tells us in the "The Cosmological Principle",

> Earlier we discussed the fact that in Einstein's theory, space is stretchable and deformable like the surface of a balloon. It can be stretched flat and smooth or it can be all wrinkled and bumpy. Combine this idea with quantum mechanics, and space becomes very unfamiliar. According to the principles of quantum mechanics, everything that can fluctuate does fluctuate. If space is deformable, then even it has the "quantum jitters." If we could look through a very high-powered microscope, we would see space fluctuating, shaking and shimmering, bulging out in knots, and forming donut holes. It would be like a piece of cloth or paper. On the whole it looks flat and smooth, but if you look at it microscopically, the surface is full of pits, bumps, fibers, and holes. Space is like that but worse. It would appear not only full of texture but of texture that fluctuates incredibly rapidly. 221

If space is "stretchable" and "jitters", this does not just apply to the very large. This applies to the quantum level as well. We know from Einstein's relativity that spacetime has relative frames. These frames of reference can be drawn on any scale. On smaller scales they have smaller effects, but they still have effects. Likewise, we know that the distortion of spacetime is the definition of gravity. We also know that space is time and time is space. Additionally, Einstein's most famous formula $e = mc^2$ tells us energy times the square of the speed of light is equal to mass. Or mass is energy and energy is mass. We have mass. This means we have energy. Our

mass will make minute changes in spacetime around us. Effectively, this means that what phenomenology calls the stretches of lived time and regionalities of lived space have a physics component. Relativity finds its philosophical expression in phenomenology. Phenomenology is not merely philosophy; it is physics as well. This should give us another indication of how historic assumptions of absolute time and space, linear time and linear extension of space, show us something about ourselves. We do not just learn history; we are history and not just our personal history. With relativity and quantum entanglement a new history is developing which we can welcome with wonder and awe and attention, or we can try to force a history which is rapidly fading.

What I am trying to show here is how deeply entrenched ways our lived historicity abstractly holds sway over our concrete lived experiences. This should indicate a certain kind of way in which we are, a capacity we have which simultaneously defines us and imprisons us. When these phenomenological capacities start to break down our social norms become less functional, we face a precipice. We can either decide to violently reinstate our conventional historical narratives to conserve a supposed worldview. This appears to reduce consternation and guarantee order but only becomes a reactionary case of diminishing returns. Or we can reflect on the causes for these breakdowns and consider the inadequacies of our historic certainties. Another practical outcome of doing the latter has been termed adaptation.

In the later 20th century postmodernism became popular across Europe especially in Italy and France with Jean-François Lyotard, Jacques Derrida, and Jean Baudrillard. Derrida finds recurrent textual narratives running through modernity which undermine themselves from within. He tells us that these narratives undermine themselves from within in what Derrida calls 'logocentrism'. Baudrillard looks at modernity as a hyperreality which is merely simulacrum. By simulacrum he means that historic repetition has made so many copies of themselves that there is no original

anymore. There are only endless copies of values and meanings which can only replenish themselves with more and more extremism and fanaticism. Baudrillard tells us,

> Baudrillard presents hyperreality as the terminal stage of simulation, where a sign or image has no relation to any reality whatsoever, but is “its own pure simulacrum”. The real, he says, has become an operational effect of symbolic processes, just as images are technologically generated and coded before we actually perceive them. This means technological mediation has usurped the productive role of the Kantian subject, the locus of an original synthesis of concepts and intuitions, as well as the Marxian worker, the producer of capital though labor, and the Freudian unconscious, the mechanism of repression and desire. “From now on,” says Baudrillard, “signs are exchanged against each other rather than against the real”, so production now means signs producing other signs. The system of symbolic exchange is therefore no longer real but “hyperreal.” Where the real is “that of which it is possible to provide an equivalent reproduction,” the hyperreal, says Baudrillard, is “that which is always already reproduced”. The hyperreal is a system of simulation simulating itself. 222

Bereft of meaning, an epoch ends in a whimper while extremism only appends this end with violence and authoritarianism. What is meant by the 'death of an age' seems to me to have an analogous relationship with the difference between Heidegger and Levinas on death. Both find a phenomenological experience of death as 'my death'. Heidegger tells us that my death is the possibility of the absolute impossibility of '*Dasein*' or the ‘there’ of being, my being. This absolute impossibility of my 'there of being' is more than a mere contradiction. Death recoils, overflows itself, on our lived experience from my lived impossible future to my present.

Therefore, Heidegger's notion of death reaches back to me as my ownmost possibility for authenticity. Levinas tells us that death is my most severe experience of passivity, as my suffering of death. Levinas tells us death is not something which grants power as the possibility for authenticity reaching back from 'my death' but an externality which comes to us passively in which we are no longer 'able to be able' in the suffering of death.

> Levinas characterizes Heidegger's view as one that emphasizes the assumption of a position of virility, power, and mastery in the face of death. In contrast, Levinas argues that death is the most radical experience of passivity and impossibility, in which one is 'no longer able to be able'—emphasizing that death is not something assumed, but rather something that comes. The futurity of death as something to come (à venir) means that the encounter with death is an encounter with something other, a conclusion that Heidegger does not make in relation to his own understanding of the futurity of death. 223

I see echoes of this phenomenological reduction as what marks the end of an age, an epoch. However, when the death of an age is thought in terms of virility and possibility, Nietzsche's overman, *Ubersmensch*, more colloquially superman, it must desperately refresh itself on its ownmost, age-wise understanding of authenticity. This means it must perpetually return to a copy, yet another simulacrum, of its narrative which it gives itself - 'the old days were blah, blah, blah'. As the heroic old days become harder and harder to prop up in its disappearance, it must revert to desperation, exasperation, fanaticism, and finally, violence. The end of our current epoch can no longer thrive on tired narratives of absolute 'values'. 'Absolute' itself has submerged in a sea of relativity where uncertainty is not a suspension until we can reestablish yet another simulation of certainty. This is not a

hermeneutical pause which will find its footing yet again in an underlying 'reality'. This is either annihilation from climate change or nukes, whichever one comes first, or it is a step into the abyss. 'Exteriority' is no longer opposed to interiority, object to subject, other to me to be raised up into a transformative unity which binds them both in their oppositions. 'Exteriority' is not a *meta* to *phusis*, yet another metaphysics. It is analogously exhibited and hinted at by the previous discussion on exformation. Exformation leaves no room for any of the categories of modernity. Absolute time and space, cause and effect, 'reality', practicality, and the 'common' in sense now marks the tombstone of modernity in which we live and move and have our being.

For the sake of this book, let's think of the inevitable breakdown of worldview, of classicism to modernity and modernity's budding inadequacies as the disorientation of chaos, perhaps *apeiron* in the Greek sense. The breakdown of order is brought on by the uncertainty of what is no longer working (like the breakdown of the hammer). The pull of chaos is now focusing on the totalitarian death of the leveling off of 'reality' into the same. There is no new age of Aquarius which will squelch uncertainty and usher in a certain euphoria. Uncertainty remains in exteriority. Exteriority has no name but has a face - the face of the other, the he or she which practical response to responsibility cannot get subsumed yet once again in totalitarian simulacrum. This practical responsibility in the face of an other cannot be synchronized to my lived time. This is what Levinas calls Ethics. Ethics here has nothing to do with altruism which was firmly rooted in modernism from Descartes' 'thinking thing' to the monadology of Leibniz to the categories of human understanding in Kant to the Concept which rises from the dialectic of Hegel to the senses of British Enlightenment are all sealed in the certainty of modernity's tombstone.

Remember in general relativity, time is considered malleable and relative. In quantum mechanics time does not arise from phenomenon and is discrete, an auxiliary, as an independent

variable which the quantum wave function uses as an operator to distinguish between two discrete states. However, there is no implication of any physicality to temporality as general relativity assumes. This dissonance creates a conceptual conflict between the two theories, known as the problem of time. The problem of time raises questions about the nature of time in a physical sense and whether it is truly a real, distinct phenomenon. It also involves the related question of why time seems to flow in a single direction, despite the fact that no known physical laws at the microscopic level seem to require a single direction. Quantum mechanics regards time as universal and absolute, while general relativity regards time as malleable and relative. So analogously, for postmodernism time is not like general relativity or evolutionary, smooth and continuous, as a glue which binds narratives together. For postmodernism, hierarchies and logic are dispositions of power structures. Postmodernism finds these structures nothing other than historic narratives which only have an appearance of stability and continuity. At bottom, they perpetuate violence and force by establishing edicts in which identity is privileged. All this sounds a bit esoteric for many folks but its insidiousness seeps into simple commonsense and pre-understandings of 'the way it is'.

In the case of postmodernism, binary dualisms are succeeded not by logical negations but by its own logical explicit and implicit narratives. Derrida calls the appeal to apparent universal truths of logic logocentrism (l*ogos-centric*). Ok, this is too much of a narrow explanation, but the full explanation would be another book of this size. The bottom line is that both structuralism and poststructuralism are superseded by deconstruction. And so goes the history of philosophy. There is a movement in all these historic narratives towards symmetry and broken symmetry leading to (eventually in classicism) yet again symmetry. However, with postmodernism what has come later seems to me to be a somewhat stochastic proliferation of a variety of ideas. Of course, this may sound a bit like Schrödinger's idea of statistics which I mentioned

earlier. However, in terms of postmodernity Humpty-Dumpty cannot be put together again. This is the malaise of contemporary philosophy. And this is why I think quantum physics may be a bigger help than philosophy in understanding the abyss in which we face. It is interesting that the failures of classical philosophy and classical physics are now both pointed towards an abyss, primordial chaos, if you will. I do not think either philosophy or physics will be able to resolve themselves and that is the point. There will be no classical resolution into a higher order or more perfect logic as classicism leads us to believe. We are at the brink of alterity which cannot ever be reincorporated. So, back to complexity and emergence and novelty…radical alterity. From the alterity intuited in the dawn of *phusis* to the disjunctive avenues opened by the void we face in quantum physics, I want to turn to how these findings necessarily must lead us to a new understanding of each other.

THE RADICAL ALTERITY OF THE OTHER

Rather than think subjectivity in the historic garb of Being, Levinas wants to denude the historic machinery of assumptions which level the alterity of the other to the same, judgements which cover over the other with language and history that pre-understands the other as the same as my idea of the other. Levinas does this by focusing on the relational approach to the other in a very different way. In physics we might think of the relational approach as concerning boundary conditions, the collapsing of infinites in a way which is useful for assessing probabilities (think of point particles which have string-like behaviors given from extended dimensions). Over the course of this book, I have discussed the relational approach to quantum computing, relativity, Schrödinger's equation and its unitary approach to information updating. Also, recall the paper Jianhao Yang published in 2018 [224] concerning relational quantum mechanics. If one single idea could simplify quantum physics it would be how *phusis* can no longer be thought of in terms of

absolutes of time and space, completely independent and separate quantum states but as a spooky, relational approach.

Hard boundaries no longer exclude quanta from each other, subjects from objects, me from things, me from others, observers from observed. Quantum systems intermingle in reversible, bidirectional probabilistic co-determining quantum states which branches, collapses, as the observer effect simultaneously along all possible informational pathways without regard to our abstractions of a classical 'past' moving towards a 'future'. All of this highly interactivity gurgles up into our sensual, lived experience. And our branching as historic/me narratives are captured by the history of ideas into what we simply think of as plain 'ol common sense. In quantum physics boundary conditions are far removed from our abstract ideas of 'hard and clear' limits. Rather, boundaries are patterns of flux, dimly recognized patterns of waves/fields popping in and out of existence. Even in this case, boundaries are not solid, rigid particles or merely waves, fields, and patterns. Boundaries are dependent on the observer effect, complementarity and the collapse of the wave function, the branching of worlds within worlds as informational updating. Boundaries are ways we think about infinites of interactions and possibilities in order to create sense out of them. In using the phrase 'create sense' I mean truncate all these spooky, infinitely varying possibilities into some form of predictable behavior. For example, when we interact with another person, we are completely oblivious to them and us bidirectionally entangling and co-determining each other in unpredictable ways as entangled systems. We have evolved in such a way as to filter (e.g., senses) so we are not murkily changing together interaction with as barely existent globs. Our biology and our history of ideas have created practical boundaries which enable us to function in the day-to-day world. These spooky relationships defy logic, the history of physics, even of ontology, the history of Being, existence, reality. So, relational boundaries are highly contingent and impose a necessity to be thought-felt-lived under these terms. Boundaries are an odd

sort of imagined membranes which can no longer be thought of in terms of cause and effect and some monologue of evolutionary notion of progress. Boundaries are fluxes of arbitrary reference points which terminate in infinities.

For Levinas, the other infinitely exceeds even these fragile boundary conditions, but history congealed as ‘my commonsense’ terminate the other as reductions of the same. Leveling the other off to an idea of the other sets the other up for transactionalism, marketing, political rhetoric. The market of ideas even requires professional physicists to think long and hard about how to describe spookiness, so their careers are not endangered. Philosophers are also plagued with concerns about careers in their specific fields of study.

Early on in his youth Levinas focused on the sensuous way we encounter the other. The face of the other is not an interface of a thinking object-machine but sensuously affective. Affectivity gets sifted through history as ‘sensible’, modernity’s reduction of affect to the machinery of the sense organs. The five senses crystallize the affective encounter with the other as ready for processing, for categorization, predetermination, and idea. But lived affectivity always exceeds this reduction to the same. The look from the eyes of the other, their gesture, instantaneously interrupts our projected idea of the other. Our embodiment does not occur at the level of idea, thinking, and reflection.

Early on Levinas explores enjoyment, desire, touch, and the caress which does not know what it seeks in terms of an object or a thing we hold in our hands. Love and fecundity sensually draw us out towards an infinity where ‘idea‘ will not take us. The sensual living embrace and vulnerability do not live in transactionalism. The sensual experience is also of fear, horror, indolence, obsession, insomnia. These fears arise from indeterminateness, the exhaustion off the reductionary enterprise to succeed, the hollowing out of excess to identity of the same. The sensuous experience of insomnia is the absolute inability to slip away, to distract oneself. Insomnia is

an analogous example of a primal experience Levinas calls the '*il y a*'.

Il y a is a common French expression which simply means 'there is'. Levinas borrows this idea from his friend Blanchot. Leibniz in monadology writes, "Why is there something rather than nothing at all?". Levinas tells us there is no 'no-thing at all' and at the most fundamental level of awareness there is no ego, no subject and neither is there simply nothingness. The common notion of nothingness may be thinkable, but it cannot be experienced. Absolutely indeterminate, nocturnal being is still something. As mentioned perhaps we might think analogically of the unescapable, stark, and bare awareness of chaotic unassembled exformation in which the possibility of retreat is impossible. It is the absolute destitution of externality into pure chaotic presence. The 'there is' is void, empty of determination, without ego, empty of all content but still aware. The 'there is' has no 'other'. The 'there is' simply and interminable simultaneity awareness without the bare self, ego, or self-consciousness meaning awareness of awareness. It is like insomnia as the 'there' of sheer isness except sleep is never a possibility. In the history of Being, light is opposed to darkness. Darkness is the absence of light, but history's darkness remains defined by light as its other. The 'there' of sheer isness has no counter opposed to light, no contrary, to which it can appeal. It has no oppositional determinations, only atemporal awareness of the 'presencing' of nothingness. The mythologies of Hell, Hades, the underworld, etc. are sitting on a warm tropical beach sipping on a margarita compared to what Levinas is telling us.

Sheer awareness, the experience of interminable nothingness, is the paralyzing inability to be able and therefore, a persecution without object, without hope or even a notion of termination. The 'there is' has no past, present, or future. It has no memory. Levinas writes of *il y a* in the quote below,

The oneself cannot form itself; it is already formed with

> absolute passivity. In this sense it is the victim of a persecution that paralyzes any assumption that could awaken in it, so that it would posit itself for itself. This passivity is that of an attachment that has already been made, as something irreversibly past, prior to all memory and all recall. It was made in an irrecuperable time which the present, represented in recall, does not equal, in a time of birth or creation, of which nature or creation retains a trace, unconvertible into a memory. Recurrence is more past than any rememberable past, any past convertible into a present. [225]

The il y a cannot form a self. The il y a is not awareness of awareness. It is sheer awareness without content. Levinas considers the il y a as a formless void, an ambiguous and formidable 'present absence'. It represents a field of impersonal existence, devoid of meaning or purpose. This is unquenchable and interminable nothingness which finds no echo of a self. Levinas draws a parallel between the impersonal phenomenon of *il y a* and the condition of insomnia. Levinas describes the *il y a* as an impersonal, indifferent force that pervades existence. It represents the sheer facticity of existence—the inexorable presence of things, events, and beings in the world. Imagine a desolate landscape where objects, people, and events barely exist absolutely devoid of meaning. Insomnia is a sleep disorder characterized by the inability to fall asleep or stay asleep. It disrupts the natural rhythm of rest and wakefulness. Now, consider how Levinas' relates insomnia to *il y a.* Just as insomnia prevents restful sleep, *il y a* disrupts any content as sheer existence. It is like being awake, metaphorically speaking, in a state of perpetual vigilance which persists relentlessly, filling our existence with indifferent presence. Insomnia often leads to anxiety, restlessness, and a sense of unease. But *il y a* is like insomnia with the exception that it finds perpetual and interminable inability to sleep or even the inability to experience nothingness. It must stare

relentlessly without content. *Il y a* has no self. Contrarily, life is the impossibility of all our possibility to retreat from *il y a*. Might we compare life to the impossibility of all our possibility to quantum tunnelling?

In life, repulsion from the nocturnal horrific awareness of *il y a* retreats from the 'there' of sheer isness as ipseity. Ipseity is from Latin *ipse*, bare self, and the suffice '-ity' taken from *itatem*, referring to conditions or quality of being. Ipseity is the pre-reflective basic or core self. For Levinas, ipseity is recoil from the '*il y a*', the 'there' of sheer isness into selfsameness. Ipseity is horrific retreat from *il y a* to the bare determination of an 'I'. It is the escape from *il y a* which makes self-awareness possible, the birth of self-consciousness. The self does not create itself. By the necessity of life, ipseity escapes from sheer isness not from its own power but from its inability, absolute passivity, to form itself. Levinas thinks of ipseity as the raw and bare beginning of the self which must retreat from *il y a*.

> A sphere of pure sensibility was first disengaged, sphere of the nocturnal horror of the indeterminate, and of ipseity taking form as a relationship of immersion in the sensuous element, determining itself as pleasure or contentment. The relationship with things was carefully distinguished from this antecedent relationship of sensuous enjoyment and alimentation. It begins with inhabitation, the establishing of a dwelling, a zone of the intimate closed from the sphere of the alien. Things are apprehended as solid substances and movable goods, furnishings for a dwelling, before they are means and implements in a practical field. And there is a new form of ipseity identifying itself in these acts of inhabitation and appropriation, existence for oneself in the form of being at home with oneself, "être chez soi. There was already a relationship with the other at this level, a relationship through cohabitation, with the other as

> complementary and “feminine” presence. But the relationship with the other in his alterity, the ethical relationship, breaks out in the face to face position in which language takes place. The ethical nature of the relationship with a face constituted the center and principal originality of Levinas’s analyses. But Levinas described also an erotic sphere, relationship with the carnal and with the child that comes in the carnal, relationship of voluptuousness and fecundity, as “beyond” the face, a sphere over and beyond the ethical. 226

Let’s see if I can bring the *il y a* and ipseity a little closer. I am going to cite a quantum analogy here simply as an analogical way to arrive at where I think Levinas is trying to bring us with *il y a*. Please indulge me in a ‘quantum mythology’ to try to make the point. *Il y a* is along the lines of the chaotic (in classically framed terms ‘universal’) quantum wave function. Use your imagination to think of sheer awareness within the wave function. Not self-awareness but simply awareness which cannot collapse or branch into classicism. I would think the phenomenon of awareness must have some rudimentary chaotic exformation within the wave function which upon branching has the capacity to become classical self-consciousness. However, when the wave function is not observed, its state is purely and wholly indeterminate. Also, remember that temporality and spatiality are all effects of the observer effect and irrelevant to the wave function. The closest we can imagine the wave function is as our notion of simultaneity. If awareness, not awareness of awareness, has some rudimentary chaotic basis in the wave function, it would have no being, existence, reality, truth, or any ‘thing’, any coherent thought. It would not be able to gather itself - only perpetual vigilance which persists relentlessly and interminably, filling the void with absolute interminability which must nevertheless be aware. Now, imagine that observation, collapses or branches the wave function and you

are born (initially in the superposition state). We know that regardless of our perception of branching the wave function in its component of sheer awareness continues on as chaotic awareness. But in this state 'you' are in an impossibility unable to escape as being, classicism, life. Levinas might call this the impossibility of possibility.

Remembering the previous discussion of the quantum bath, we can visualize stages where a highly isolated quantum experiment is increasingly perturbed by its environment. This progressive exposure—or partial environmental immersion—moves the system toward complexity until a chaotic limit is reached. At this threshold of complexity, might we meaningfully think of a universal[227] wave function? But the transition in which the wave function branches might be like ipseity, the bare self that Levinas might have in mind. In this analogy, *il y a* is not the 'origin' of the bare self but a kind of simultaneity of layering as bare self and also as wave function. Origin is simply something we call wave function branch, collapse from the observer effect. A quick note here, ipseity born as life is not the observer. The radical alterity of the other would be the observer in this analogy (of course mom and dad also figure into this observational fecundity).

There is no temporality or spatiality, classicism, for the *il y a*. The bare self, retreating from sheer chaotic awareness, is the transition from the spooky, indeterminacy of the wave function to the branch of classicism in which the bare self retreats from il y a as ego for Levinas. It might be tempting to call this an 'origin' but that connotes a cause and effect-like situation. The wave function continues on having already incorporated the quantum state of the observer into its atemporal, aspatial chaos. The wave function does not know anything about a collapse, branch, classicism, etc. It is the simultaneity of all possibilities chaotically. So, the bare self, the ego, is more of a layering effect from *il y a*, chaotic awareness. For *il y a*, this takes the stare of Orpheus to a whole new level. Orpheus' last fixated stare is not on Eurydice but on chaos, not the

underworld, but oblivious awareness which cannot awaken. In *il y a,* the echo of Narcissus has died out eternally without even a memory of abyssal echoing.

The retreat as ipseity to oneself takes on absolute compulsion to escape *il y a*, the separation of a bare, unreflective 'me' as form from void. It is passivity as any such thing as before ipseity had no possible ability to even be passive. Escape before there was ipseity, self-sameness, is given from what Levinas calls a "*passivity more passive than all passivity*". Exteriority first speaks collapsing as ipseity, to sheer terror, awareness of inescapable nothingness; ipseity retreats void as sojourner. The "knot of ipseity" forces retreat and collapse into ego. The hither side of ipseity is the ego.

> Obsession as non-reciprocity itself does not relieve any possibility of suffering in common. It is a one-way irreversible being affected, like the diachrony of time that flows between the fingers of Mnemosyne. It is tied into an ego that states itself in the first person, escaping the concept of an ego in an ipseity — not in an ipseity in general, but in me. The knot of subjectivity consists in going to the other without concerning oneself with his movement toward me. Or, more exactly, it consists in approaching in such a way that, over and beyond all the reciprocal relations that do not fail to get set up between me and the neighbor, I have always taken one step more toward him — which is possible only if this step is responsibility. In the responsibility which we have for one another, I have always one response more to give, I have to answer for his very responsibility. 228

The ego, this infantile selfsameness is the echo of Narcissus. It is the echo chamber where Being and history play on the stage of totality, the lure into phantasms of distractions alluring oneself in endless deferments as anonymous others which come to presence. Ego teases a break from self-sameness without tearing it from its

embryonic habitat. Levinas calls this infantile auto-fascination/ affection the 'said'. The said is the production of faux essence. The said is the echo of the 'saying' from, as we will see, the radical externality of the other. It is the pacifier which amazes and delights in pure self-interest, auto-arousal. It is a self-indulgent game where Being hides from ego like peek-a-boo only to jump out in the throes of time to recapture the ecstatic immanence of the moment, of the self. In this gleeful re-presencing of itself to itself from the horrific retreat of ipseity, the ego desires to replace itself with another version of ipseity, alter-ipseity. In Freud's terms ipseity might be thought of as id. In that case, the bare self of ipseity Freud might call ego desires to replace itself from terror and retreat of *il y a* by echoing itself, replacing itself with a kinder, gentler version we call the ego too or Freud might call super ego. Levinas writes,

> The recurrence of the oneself refers to the hither side of the present in which every identity identified in the said is constituted. It is already constituted when the act of constitution first originates. But in order that there be produced in the drawing out of essence, coming out like a colorless thread from the distaff of the Parques, a break in the same, the nostalgia for return, the hunt for the same and the recoveries, and the clarity in which consciousness plays, in order that this divergency from self and this recapture be produced, the retention and protention by which every present is a re-presentation — behind all the articulations of these movements there must be the recurrence of the oneself. The disclosure of being to itself lurks there. Otherwise essence, exonerated by itself, constituted in immanent time, will posit only indiscernible points, which would, to be sure, be together, but which would neither block nor fulfill any fate. Nothing would make itself. The breakup of "eternal rest" by time, in which being becomes consciousness and self-consciousness by equalling itself after the breakup,

> presuppose the oneself. To present the knot of ipseity in the straight thread of essence according to the model of the intentionality of the for-itself, or as the openness of reflection upon oneself, is to posit a new ipseity behind the ipseity one would like to reduce. 229

Typical of Levinas, he packs a lot of his experiences and knowledge of the history of philosophy into a few sentences. I will unpack some of this. In the quote above Levinas thinks analogously of essence like the game of Parques.[230] Parques looks for a break with the same (jail) only in nostalgia to return to the same (jail) if captured by another player. Levinas likens this game to the narcissistic thrill of essence, delighting and disappointing itself in its victories and defeats. This game is where consciousness plays in Husserl's terms as retention and protention. For Husserl, consciousness is an **intentional** stretch upon a field spanned by an immediate present, building on the living past moment he calls retention and projecting towards a future. This is a living present moment to come he calls protention.[231] Retention is analogously like a previous classical analog state that is not like a particular thought but an accumulation of each past intentional moment into the present intentional moment. It might be thought of as a living intentional field which accumulates the past analog state into its current analog state. At the same present moment, protention is a living intentional moment which projects upon a future moment which opens up towards possibility. It might be thought of as a living intentional field which anticipates the probable future analog state from its current analog state. A musical song is a bit like this as it builds from previous harmonic constructions which anticipate future harmonic constructions. Maurice Merleau-Ponty (1908-1961) has a good description of retention and protension below,

> Husserl uses the terms protentions and retentions for the intentionalities which anchor me to an environment. They do

> not run from a central I, but from my perceptual field itself, so to speak, which draws along in its wake its own horizon of retentions, and bites into the future with its protentions. I do not pass through a series of instances of now, the images of which I preserve and which, placed end to end, make a line. With the arrival of every moment, its predecessor undergoes a change: I still have it in hand and it is still there, but already it is sinking away below the level of presents; in order to retain it, I need to reach through a thin layer of time. It is still the preceding moment, and I have the power to rejoin it as it was just now; I am not cut off from it, but still it would not belong to the past unless something had altered, unless it were beginning to outline itself against, or project itself upon, my present, whereas a moment ago it was my present. When a third moment arrives, the second undergoes a new modification; from being a retention it becomes the retention of a retention, and the layer of time between it and me thickens.[232]

In Levinas' previous quote "*behind all the articulations of these movements there must be the recurrence of the oneself*", he critiques Nietzsche's metaphysics of eternal return of the same self which is always arises from the classical metaphysics of essence. The great iconoclast himself uses the most sacred truth of Western religion and philosophy – the essence of self which must always return to the same, to distinguish his early Greek heights of the Übermensch. I have no doubt Nietzsche was well aware of his humorous and ingenious folly (at least in his mind) play upon classicism with Zarathustra's eternal recurrence of the same. Nietzsche thought the highest aspiration was to play with truth. In "Beyond Good and Evil" he writes,

> The Will to Truth, which is to tempt us to many a hazardous enterprise … what questions has this Will to Truth not laid

> before us! What strange, perplexing, questionable questions! It is already a long story; yet it seems as if it were hardly commenced. Is it any wonder if we at last grow distrustful, lose patience, and turn impatiently away? … We inquired about the value of this Will. Granted that we want the truth: why not rather untruth? And uncertainty? Even ignorance? [233]

Imagine if everything in everyone's life was to be repeated over and over again in exactly the same way forever. Nietzsche called this truth the great nausea. I think Nietzsche believed that the endless repeat of the same life over and over again would neutralize the instinct for classical truth and certainty. Yet, in this void Nietzsche would fill it with his heroic and unabashed elitism; with a moment of joyful bliss in nevertheless affirming life. In "Thus Spake Zarathustra", the section entitled "The Vision and the Enigma" he writes about a creature half-dwarf and half-mole which reveals the doctrine of eternal recurrence to Zarathustra. Though the creature's discourse on eternal recurrence a snake crawls down the throat of Zarathustra. This is the great nausea. The creature tells Zarathustra to bite the head off the serpent. When Zarathustra bites the head of the serpent, he has affirmed life and Nietzsche writes of Zarathustra, "*No longer shepherd, no longer man—a transfigured being, a light-surrounded being, that laughed! Never on earth laughed a man as he laughed! O my brethren, I heard a laughter which was no human laughter,—and now gnaweth a thirst at me, a longing that is never allayed. My longing for that laughter gnaweth at me: oh, how can I still endure to live! And how could I endure to die at present!*" Nietzsche understood that humans stood at the abyss. Yet, his evocation was to revel in the bliss of his own warrior spirit of conquest and triumph over every pompous truth he despised in classicism. Instead of radical alterity Nietzsche chose radical selfhood. Nietzsche chose jubilant echo of his prowess over an ethical possibility towards the other.

Permeating ancient Greece from the earliest to the latter citizens and thinkers and very important to Aristotle, was the notion of *kairos* meaning 'the opportune moment'.[234] The temporality of Nietzsche's triumph moment of affirmation in the face of eternal recurrence of the same is a good way to think about the Greek notion of time as *kairos. Kairos* is the opportune moment. It is the temporality of quality as I discussed earlier. *Kairos* is the moment of culmination, completion, ultimate fulfillment captured by *telos*. This is the moment when all tragedy of life is conquered by only the few, the brave, the warrior soul. Nietzsche's moment of *kairos* elevates himself to the rare mountainous peaks of grandeur. Radical alterity is finally and completely effaced by the heroic and elite self. This is the legacy of Nietzsche's echo of himself to himself. This is everything classical essence was supposed to be but failed. In Nietzsche's heroic identity, there is a continuum of the self in an analogous way like relativity. The self is an essence, e.g., spacetime, which continues smoothly in curving and bending but never breaks or gets interrupted by any exteriority. Even in the massive bending of spacetime in a blackhole, there is no break but perhaps a metaphysical-like leap as a singularity (or Zarathustra). For Nietzsche, the essence of the self is preserved at all costs in the eternal triumph of heroic *kairos*. I am not going to take up a lot of space in this book to shed more light on Nietzsche's obsession with his grandeur and particularly nasty comments on women.

Levinas criticizes Hegel along the same lines of eviscerating any notion of radical alterity when he writes that, "*behind all the articulations of these movements there must be the recurrence of the oneself. The disclosure of being to itself lurks there. Otherwise essence, exonerated by itself, constituted in immanent time, will posit only indiscernible points, which would, to be sure, be together, but which would neither block nor fulfill any fate. Nothing would make itself. The breakup of "eternal rest" by time, in which being becomes consciousness and self-consciousness by equalling itself after the breakup, presuppose the oneself.*" Radical alterity cannot exist or even rise up into

Concept for Hegel as it will always be recuperable. All the way from Being and nothingness to the self and other to individuality and collectivity to Concept to space and time and back to Being and nothingness all over again *ad infinitum* there are no breaks, no discontinuities. Everything is anticipated and retained smoothly, logically, continuously as many continuous convolutions. Perhaps similar analogically to the spacetime of relativity. Classicism retains continuity in identity throughout in one way or another. Incomprehensible breaks must always be reappropriated in the return to essence. "*Eternal rest*" is the absolute immanence of Concept. "*Indiscernible points*" cloaks both an allusion to Leibniz and the Hegel's concept of space and time. Concept forgetting itself as indiscernible points can "*neither block nor fulfill any fate*" as mortals can do. For Hegel, the "*breakup of "eternal rest" by time*" is ultimately when Being becomes "*consciousness and self-consciousness* by *equalling itself after the breakup*" in the presupposition of oneself. Levinas' high-density ridicule at the expense of essence and Being is typical of Levinas' fun-poking derision and genius of the history of philosophy. But Levinas does not want to just be a Nietzschean styled iconoclast. He wants to propose a radical alterity which cannot be found by identity, by logic, by Being, by Concept, or by essence. In a way Levinas' technique might be compared analogously with the breakup of relativity by the spooky quantum wave function and its odd observer effect which does not overcome or paper over externality but leaves it dangling without completion, without fulfillment, incapable of being answered classically as essence in all its facades. I am reminded of Levinas' words below,

> To conceive the otherwise than being we must try to articulate the breakup of a fate that reigns in essence, in that its fragments and modalities, despite their diversity, belong to one another, that is, do not escape the same order, do not escape Order, as though the bits of the thread cut by the Parque were then knotted together again. This effort will

look beyond freedom. Freedom, an interruption of the determinism of war and matter, does not escape the fate in essence and takes place in time and in the history which assembles events into an epos and synchronizes them, revealing their immanence and their order.

The task is to conceive of the possibility of a break out of essence. To go where? Toward what region? To stay on what ontological plane? But the extraction from essence contests the unconditional privilege of the question "where?"; it signifies a null-site [non-lieu]. The essence claims to recover and cover over every ex-ception — negativity, nihilation, and, already since Plato, non-being, which "in a certain sense is." It will then be necessary to show that the exception of the "other than being," beyond not-being, signifies subjectivity or humanity, the oneself which repels the annexations by essence. 235

Let's get back to the retreat of ipseity from the horror of *il y a*. While this may sound dramatic, what Levinas is getting at is the historic inadequacy and inability of the ego to be Superman, to be eternal essence, to be the heroic overcomer, to immortalize itself. Instead, we see the ego as dying, as getting old, as failing to complete itself. The ego approaches its history, its 'me-ness' in the practical everydayness as dismal. It is unable to rise to the heights of immortality, of greatness, of godhood in its inexhaustible echo of itself from and in and through history into the where of 'me'. Levinas continues the quote from above,

The ego is an incomparable unicity; it is outside of the community of genus and form, and does not find any rest in itself either, unquiet, not coinciding with itself. The outside of itself, the difference from oneself of this unicity is non-indifference itself, and the extra-ordinary recurrence of the pronominal or the reflexive, the self (se) — which no longer

> surprises us because it enters into the current flow of language in which things show themselves, suitcases fold and ideas are understood (les choses se montrent, les bagages se plient et les idées se comprennent). A unicity that has no site, without the ideal identity a being derives from the kerygma that identifies the innumerable aspects of its manifestation, without the identity of the ego that coincides with itself, a unicity withdrawing from essence — such is man. 236

But as I have introduced throughout this book with the notion of intuition, Levinas also finds a threat of intuition which only, always must be reappropriated into the said (classicism), into the same which does not allow and cannot follow the thread of the externality of the other.

> The history of philosophy, during some flashes, has known this subjectivity that, as in an extreme youth, breaks with essence. From Plato's One without being to Husserl's pure Ego, transcendent in immanence, it has known the metaphysical extraction from being, even if, betrayed by the said, as by the effect of an oracle, the exception restored to the essence and to fate immediately fell back into the rules and led only to worlds behind the scenes. The Nietzschean man above all was such a moment. For Husserl's transcendental reduction will a putting between parentheses suffice — a type of writing, of commiting [sic] oneself with the world, which sticks like ink to the hands that push it off? One should have to go all the way to the nihilism of Nietzsche's poetic writing, reversing irreversible time in vortices, to the laughter which refuses language.
>
> The philosopher finds language again in the abuses of language of the history of philosophy, in which the unsayable and what is beyond being are conveyed before us. But negativity, still correlative with being, will not be

enough to signify the other than being. 237

As mentioned, the alter-ipseity, the impossible ego of classical histories, of oneself are not rooted in its own agency, in its illusory play as Idea in the midst of Being. Levinas terms this illusory play 'freedom'. It is the freedom played in the arena of self-creation/subsistence as alter-ipseity. It is the freedom of transactionally echoing oneself to oneself in which ego pays its losing hand to the bitter end. The anarchy of ego, of oneself, cannot be reduced to the 'not' of origin. It cannot play in that historic arena which is doomed to lose. Why? Because it only dreams in echoes of itself in the face of its lack of self-origin. Levinas tells us,

> The oneself has not issued from its own initiative, as it claims in the plays and figures of consciousness on the way to the unity of an Idea. In that Idea, coinciding with itself, free inasmuch as it is a totality which leaves nothing outside, and thus, fully reasonable, the oneself posits itself as an always convertible term in a relation, a self-consciousness. But the oneself is hypostasized in another way. It is bound in a knot that cannot be undone in a responsibility for others. This is an anarchic plot, for it is neither the underside of a freedom, a free commitment undertaken in a present or a past that could be remembered, nor slave's alienation, despite the gestation of the other in the same, which this responsibility for the other signifies. In the exposure to wounds and outrages, in the feeling proper to responsibility, the oneself is provoked as irreplaceable, as devoted to the others, without being able to resign, and thus as incarnated in order to offer itself, to suffer and to give. It is thus one and unique, in passivity from the start, having nothing at its disposal that would enable it to not yield to the provocation. It is one, reduced to itself and as it were contracted, expelled into itself outside of being. The exile or refuge in itself is without

> conditions or support, far from the abundant covers and excuses which the essence exhibited in the said offers. In responsibility as one assigned or elected from the outside, assigned as irreplaceable, the subject is accused in its skin, too tight for its skin. Cutting across every relation, it is an individual unlike an entity that can be designated as τόδε τι ['this' as primary essence in Aristotle]. Unless, that is, the said derives from the uniqueness of the oneself assigned in responsibility the ideal unity necessary for identification of the diverse, by which, in the amphibology of being and entities, an entity signifies. 238

In "Otherwise than Being or Beyond Essence" the infinitesimal moment of saying, of the other, to me is the moment before sensual encounter which has not yet crystalized into the said of Being, of thought, of idea. All of this should point us toward the radical alterity of the other which refuses my ideas, judgments, reduction to our repetitive accustomization (common sense) from history leveling off the encounter of the other to the same thought of as the identity of my idea of the other. Levinas writes of the other, the face-to-face encounter with him or her (or more recently, nonaligned with a specific gender) as a barely perceptible boundary of sensuality infinitely exceeded by the radical alterity of the other. The saying of the other which dissipates prior to the temporality of the said, must always be captured and recuperated into the synchrony or the classic temporality of history and Being. Levinas refers to this dissipation or lapse prior to temporality as diachrony and proximity. Diachrony here denotes an abrupt disjunction of temporality between myself and the other. By diachrony Levinas refers to an anarchic excess to temporality with the other which is not contained as 'my time', 'my past, present, or future'.

Analogously perhaps we could associate diachrony to the quantum wave function which can never take hold of some objective other of classical ontology. In this sense, synchrony

reflects my branching into informational updates which must always re-imagine itself as the said. However, Levinas' lapse prior to 'informational updating' is not informational at all. It is a call for responsibility to the other in the form of an accusation which must be responded to either from the retreat to ego or the persecution of self. The encounter with the other is not like two computers sharing data. The other is not in my 'informational updating', my temporalizing embodiment. I am not the container of the other. Even more so, the other is on the hither side of my being and Being, which cannot come into presence and its equivocations. The encounter with the other is a diachronous lapse of moments of our freedom of choice which in its pure signifyingness without any object imposes responsibility. This responsibility is not a choice of ethics but an extreme difference which cannot simply fall into traditional categories of ethics and altruistic concern. This is Levinas' distinction as Ethics will be discussed a little further down. Previously, in this book I have used 'proximity' in a conventional sense to mean nearness. However, Levinas uses proximity in a special way to indicate disjunction between myself and the other which cannot be bridged, an anarchic, non-spatiotemporal encounter of the other which is more along the lines of spooky entanglement.

For exformation we would think of the spooky quantum wave function which fails us for words, for easy answers provided from classical history. We might like to call it ideal, potential, mathematical, etc. but its 'isness' *is* precisely the question which finds no answer. However, Levinas' alterity of the other is similarly unable to find voice in the said of language and thought. But instead of the spooky we have responsibility. I have referred to entanglement as emerging spacetime. For Levinas, the emergence of me, of subjectivity, is not branching of the wave function but the other who speaks (shall I say observes). Maybe, some would be tempted to think that there is some spooky *phusis* with the encounter of the other which has something to do with the wave

function and entanglement. I have also found both ideas to have intriguing similarities but there is quite a distance as well between these two notions in Levinas.

Levinas wants us to once and for all put away these ideas of information, of some kind of mere physics or philosophy which finds its avenues in physics's journals and magazines. What I have tried to do in this book is present physics and philosophy more like ancient intuitions of *phusis* which recognized no chasm between physics and philosophy. I have tried to present this material as best I can with clarity and important relevance as a departure from the academically secure ways of guaranteeing one's economic security. Of course, there are professional physicists and philosophers who, like Levinas, are willing to step away from these considerations like Susskind, Everett, Einstein, Bohr and numerous others. I want to make sure that what is at stake in physics today is not taken by others as business as usual. It has affected and will affect more and more commonsense, cultural values and *mores.* 239 I want to present this material as a precipice upon which history and culture cannot bridge, as a step into the abyss. This is why Levinas is so important to this discussion. In Levinas there is a confrontation with the sleep of common culture fueled by the history of Being. Levinas is not just another philosophy in the ongoing saga of Being. The departure of what Levinas is telling us which physics is unable to articulate, is what the alterity of the other calls to us, to our accusation, and responsibility to the other. Physics certainly does bring us to a departure from history which makes the escape attempt back into business as usual in working physics. Levinas goes further in telling us radical alterity does not end in spookiness but in undeniable responsibility, to the other from which all Being, history, day to day indifference, even in our retreat.

Levinas has a knowledge of philosophy which puts him in the highest echelons of scholars which have ever existed. His writing is very dense and displays skills intimately acquainted with the history of philosophy and contemporary philosophical problems.

However, unlike many philosophers his writing is not oriented towards academic security. He is more than willing to speak distinctly about the historic avenues into which Being falls in statements like this,

> The way of thinking proposed here does not fail to recognize being or treat it, ridiculously and pretentiously, with disdain, as the fall from a higher order or disorder. On the contrary, it is on the basis of proximity that being takes on its just meaning. In the indirect ways of illeity, in the anarchical provocation which ordains me to the other, is imposed the way which leads to thematization, and to an act of consciousness. 240

Essence: The Violence of Origin Over Radical Alterity

I want to preface this section with the remark that Levinas does have an account for how our histories of essence and Being come about vis-à-vis the third other. So, his account does not simply end in a skepticism of all this. This will be explored in the section entitled, “The Third Other”.

Levinas wants to demonstrate how two of the most important philosophers in more recent history, Hegel and Heidegger, still perpetuate the absorption of thematization as essence and consciousness as ontic subjectivity in the identification with Concept and ontology in Being. They do this by introducing and sustaining their own unique understanding of temporality which I discussed earlier (“On Hegel” and “On Heidegger”).

In early Heideggerian thought, falling into inauthenticity reduces the individual to the conformist they-self (*das Man*), stripping care (*Sorge*) of its temporal depth. However, a resolute embrace of the 'there' rescues *Dasein* from existential anxiety and insignificance. This authenticity manifests as a commitment to future possibilities, grounding the individual in a nurturing, active

care (*Fürsorge*) for both others and the world. [241] This 'there of being' carries both ontic and ontological weight, linking the individual human being to the historical enigma of Being. Rather than viewing these terms as static nouns, Heidegger frames them as verbs. Existence becomes a dynamic process—an ontic 'there-ing' of *Dasein* that allows the broader, ontological happening of Being to disclose and conceal itself through history.

Sorge is a central concept in Heidegger's philosophy and plays a crucial role in understanding human existence as authentic. As already discussed, Heidegger's philosophy focuses on *Dasein*, which refers to human existence. *Dasein* is not just an abstract concept; it represents our actual being in the world. *Sorge* (often translated as "care") is a fundamental structure of *Dasein*'s existence. It encompasses both an inner state and an external cause. *Sorge* involves a complex interplay of anxiety, worry, and concern. It's not merely about practical care or everyday worries; it delves into our existential condition. When we care, we are attuned to the world, anticipating the future, and apprehensive about our possibilities. Heidegger describes *Sorge* as having three dimensions of time:

- Past: Concern for our history, memories, and past experiences.
- Present: Attentiveness to the current moment and our ongoing existence.
- Future: Anxiety about what lies ahead, our potential, and our choices.

Authenticity in Heidegger's thought involves embracing our unique possibilities and living in accordance with our true self. *Sorge* is essential for authenticity because it reveals our being-as-an-issue—our constant questioning and engagement with existence. *Sorge* is more than mere care; it's authentic, is the existential fabric that shapes choices as existentiality, fears as facticity, and aspirations as fallenness. In "Being and Time", Heidegger gives us

his notion of *Dasein*'s temporality as "ahead-of-itself", "Being-already-in", and "Being-alongside". 242

> Through the unity of the items which are constitutive for care—existentiality, facticity, and fallenness—it has become possible to give the first ontological definition for the totality of Dasein's structural whole. We have given an existential formula for the structure of care as "ahead-of-itself—Being-already-in (a world) as Being-alongside (entities encountered within-the-world)".(2) We have seen that the care-structure does not first arise from a coupling together, but is articulated all the same.(x) In assessing this ontological result, we have had to estimate how well it satisfies the requirements for a primordial Interpretation of Dasein.(xi) The upshot of these considerations has been that neither the whole of Dasein nor its authentic potentiality-for-Being has ever been made a theme. The structure of care, however, seems to be precisely where the attempt to grasp the whole of Dasein as a phenomenon has foundered. The "ahead-of-itself" presented itself as a "not-yet". But when the "ahead-of-itself" which had been characterized as something still outstanding, was considered in genuinely existential manner, it revealed itself as Being-towards-the-end—something which, in the depths of its Being, every Dasein is. We made it plain at the same time that in the call of conscience care summons Dasein towards its ownmost potentiality-for-Being. When we came to understand in a primordial manner how this appeal is understood, we saw that the understanding of it manifests itself as anticipatory resoluteness, which includes an authentic potentiality-for-Being-a-whole—a potentiality of Dasein. Thus the care-structure does not speak against the possibility of Being-a-whole but is the condition for the possibility of such an existentiell potentiality-for-Being. In the course of these analyses, it became plain that the

existential phenomena of death, conscience, and guilt are anchored in the phenomenon of care. The totality of the structural whole has become even more richly articulated; and because of this, the existential question of the unity of this totality has become still more urgent. 243

In its anticipatory resoluteness, Dasein has now been made phenomenally visible with regard to its possible authenticity and totality. The hermeneutical Situation(iv) which was previously inadequate for interpreting the meaning of the Being of care, now has the required primordiality. Dasein has been put into that which we have in advance, and this has been done primordially—that is to say, this has been done with regard to its authentic potentiality-for-Being-a-whole; the idea of existence, which guides us as that which we see in advance, has been made definite by the clarification of our ownmost potentiality-for-Being; and, now that we have concretely worked out the structure of Dasein's Being, its peculiar ontological character has become so plain as compared with everything present-at-hand [as in the lived mode of science which phenomenally looks in the mode of present at hand or experimentation], that Dasein's existentiality has been grasped in advance with sufficient Articulation to give sure guidance for working out the existentialia conceptually.

The way which we have so far pursued in the analytic of Dasein has led us to a concrete demonstration of the thesis(v) which was put forward just casually at the beginning—that the entity which in every case we ourselves are, is ontologically that which is farthest. The reason for this lies in care itself. Our Being alongside the things with which we concern ourselves most closely in the 'world'—a Being which is falling—guides the everyday way in which Dasein is interpreted, and covers up ontically Dasein's authentic Being, so that the ontology which is directed towards this entity is denied an appropriate basis. Therefore the primordial way in which this entity is presented as a phenomenon is anything but obvious, if even

ontology proximally follows the course of the everyday interpretation of Dasein. The laying-bare of Dasein's primordial Being must rather be wrested from Dasein by following the opposite course from that taken by the falling ontico-ontological tendency of interpretation.

Not only in exhibiting the most elemental structures of Being-in-the-world, in delimiting the concept of the world, in clarifying the average "who" of this entity (the "who" which is closest to us—the they-self), in Interpreting the 'there', but also, above all, in analysing care, death, conscience, and guilt—in all these ways we have shown how in Dasein itself concernful common sense has taken control of Dasein's potentiality-for-Being and the disclosure of that potentiality—that is to say, the closing of it off. (Heidegger, 1959, pp. 562-563)

Sorge as the lived, authentic temporality of *Dasein* underlies the inauthentic lived mode of everydayness as *das man*, the they-self. The temporality of 'being there' as *Sorge* is simply assumed in the verb to-be, the 'is', 'are', 'was', etc. Heidegger has a 20th century understanding of temporality not as static 'now' moments but as having a lived-stretch from past (*Vergangenheit*, thrownness, disposedness) through a present (*Gegenwart*, projection, understanding) and towards a future (*Zukunft*, fallenness, fascination, anticipation, ahead-of-itself as not-yet, Being-towards-the-end, death). 244 Heidegger's idea of temporality has nothing to do with the abstract, linear 'now' moments of classicism except perhaps in the mode of inauthentic being-in-the-world. You might think that his notion of being as for inauthenticity is submerged in everydayness or in authenticity is the temporality of *Sorge* as similar to Levinas' ego in retreat from radical alterity or self in persecution from the radical alterity of the other as resembling each other. To some superficial extent, it does. But, in the mode of authenticity there is the possibility for recovering one's "ownmost possibility". For Levinas there is no recovery of the radical alterity of the other. For Levinas there is never a possibility of recovering saying from

the radical alterity of the other.

For Hegel, thinking rises up above, and from Being into Concept. Being is only a moment in the dialectic which in Concept becomes the subject of all predicates and verbs (to be). There is no disjunctive break in Hegel's dialectic. Each stage consumes and preserves as evolutionary transformations and eventually devolution all over again. Perhaps some in the Hegelian tradition might deem this to be simultaneous as well. The 'all over again" is echoed throughout history. This is the temporality of life, death, and rebirth, the endless cycle of yen/yang, Shiva as creation and destruction, self-awareness as "I am Shiva", atman (soul, self, interiority) and Brahman (god, not self, exteriority, growth, *rhyzo-phusis to chaogenesis*). This is Nietzsche's eternal recurrence of the same self. But for Hegel there is a progressiveness which does not abandon the prior but holds all together in higher evolutions which must end as necessity, as absolute which recovers and exceeds subjectivity as essence. But Levinas wants to make an abrupt distinction which cannot find essence and resolve. The reason that ethics can never be fundamental in any branching, classical system, is because the echo must always find itself back to itself. The echo must always recover itself. The other is recoverable in Being and Concept. There can be no basis for Ethics. Ethics is not ethics if it must always resound back from 'x'. Ethics proceeds from responsibility which has no possibility of return, no seat of sovereignty, rule, and origin or *telos*. In this way the quantum wave function provides a better pedagogical analogy for how to distinguish between other traditions which want to diminish the void into recoverability. Concerning ethics, Levinas writes,

> The ethical language we have resorted to does not arise out of a special moral experience, independent of the description hitherto elaborated. The ethical situation of responsibility is not comprehensible on the basis of ethics. It does indeed arise from what Alphonse de Waelhens called

> nonphilosophical experiences, which are ethically independent. The constraint that does not presuppose the will, nor even the core of being from which the will arises (or which it breaks up), and that we have described starting with persecution, has its place between the necessity of 'what cannot be otherwise' (Aristotle, Metaphysics, E), of what today we call eidetic necessity, and the constraint imposed on a will by the situation in which it finds itself, or by other wills and desires, or by the wills and desires of others. The tropes of ethical language are found to be adequate for certain structures of the description: for the sense of the approach in its contrast with knowing, the face in its contrast with a phenomenon. 245

Here Levinas is telling us that Ethics is not ethics as we normally think about it. What Levinas means by Ethics "*does not arise out of a special moral experience*". What Levinas refers to as responsibility "*is not comprehensible on the basis of [what we normally think of as] ethics*". Levinas' ethics is not about the 'ought' of ethics. Neither does it arrive to us philosophically. Ethics is non-philosophical experience which is independent from the traditional sense of the 'ought' of ethics. Ethics is not about free will to decide to be ethical. Neither is it based on the authenticity of being or essence. Levinas says it is the between of "*what cannot be otherwise*" and what is imposed on us by "*other wills and desires, or by the wills and desires of others*". Levinas wants to draw a sharp contrast with "knowing" and the irreducibility of the he or she we face. This reinforces what I was referring to earlier concerning the 'yawning gap', the incompleteness of knowledge in its historic grounding.

Think about the quantum wave function and the abyss which makes ontology and epistemology unable to give or find an answer. Similarly, the radical alterity of the other which we face prohibits any possibility for recovery back into classicism, essence, Being, logic, etc. only leaving us with a debt which cannot be repaid. The

self for Levinas does not arise from some whole, some absolute, some essence. Analogously, if we, me, the 'I' arises from branching of the quantum wave function, it arises from an unbridgeable abyss. 'Me' is retreat from an abyss, a yawning gap, from chaos, radical alterity which cannot be consumed in binary dualism but must always exceed classical narratives. The other, the he or she, is not an answerable to me or even has no way of being made commensurate to me as a product of me, or history, or narrative. The other we face is the demand of chasm in saying. In facing the *il y a* as sheer isness we face radical alterity which I cannot take hold of, cannot temporalize, cannot conceive, cannot 'be' or not 'be'. It would be as if we imagined we could just crawl back into the wave function. The retreat from *il y a* as the Gordian knot of ipseity arising into egoity is not a 'taking hold of the quantum wave function' as if to own it and neither can ipseity's retreat arising into self find a 'not' of taking hold of exteriority. The spooky relation is in saying, the face to face in which origin or the 'not' of origin can arrive to me is nonsensical except in the 'hallowed' echoes from the hall of historic narrative which I mistakenly think of as mine, truth, reality, plain ol' common sense. This is where Levinas leaves the spookiness of the quantum wave function as the proximity of the other as "an immemorial past". Levinas writes,

> But is subjectivity thus conceived in what is irreducibly its own? Hegel and Heidegger try to empty the distinction between the subject and being of its meaning. In reintroducing time into being they denounce the idea of a subjectivity irreducible to essence, and, starting with the object inseparable from the subject, go on to reduce their correlation, and the anthropological order understood in these terms, to a modality of being. In the Introduction to the Phenomenology of Mind, in treating as a "pure pre-supposition" the thesis that knowing is an instrument to take hold of the Absolute (a technological metaphor) or a medium

through which the light of truth penetrates the knower (a dioptic metaphor), Hegel denies that there is a radical break between subjectivity and the knowable. It is in the midst of the Absolute that the beyond takes on meaning; essence, understood as the immanence of a knowing, is taken to account for subjectivity, which is reduced to a moment of the concept, of thought or of absolute essence. Heidegger says, in a remark at the end of his Nietzsche (Vol. II, p. 451), that the "current term subjectivity immediately and too obstinately burdens thought with deceptive opinions that take as a destruction of objective being any reference from Being to man and especially to his egoity." Heidegger tries to conceive subjectivity in function of Being, of which it expresses an "epoque": subjectivity, consciousness, the ego presupposes Dasein, which belongs to essence as the mode in which essence manifests itself. But the manifestation of essence is what is essential in essence; experience and the subject having the experience constitute the very manner in which at a given "epoque" of essence, essence is accomplished, that is, is manifested. Every overcoming as well as every revaluing of Being in the subject would still be a case of Being's essence. 246

Perhaps Aristotle called this event *ousai* which is Greek for pure actuality, awareness, and as a moving *telos*, goal, culmination which is not moved itself. Heidegger actually criticizes the latter Greek priority of presencing taking up by Latin Christianity into the God of light in which darkness is no more. Heidegger thinks privation gets lost as co-arising from Heraclitus and the earlier Greeks.

When Heidegger observes that Plato's interpretation of the beingness of beings rests on the experience of ov as ousia, Heidegger has in mind the constancy and presence of beings, emerging on their own (vom ihm selbst her), where

> ‘emerging’ precisely means coming out from being closed off, concealed, and folded in upon itself (GA 55: 87). As Heidegger puts it in another context, “ousia names that within which, from the outset, earth and sky, sea and mountains, tree and animal, human being and God emerge and, as emerging, show themselves in such a way that, in view of this, they can be named ‘beings’. [247]

When time began or if it never had a beginning has been debated throughout the whole history of physics, philosophy, and religion. When time begins is inseparable from questions of origin. Some have said it always was, it was eternal. Others have told us the beginning came from nothing.

> The ancient Greeks debated the origin of time fiercely. Aristotle, taking the no-beginning side, invoked the principle that out of nothing, nothing comes. If the universe could never have gone from nothingness to somethingness, it must always have existed. For this and other reasons, time must stretch eternally into the past and future. Christian theologians tended to take the opposite point of view. Augustine contended that God exists outside of space and time, able to bring these constructs into existence as surely as he could forge other aspects of our world. When asked, What was God doing before he created the world? Augustine answered, Time itself being part of God's creation, there was simply no before! [248]

As we have seen, more recent physics suggests time is not fundamental. In relativity time is not really different from space in its dimensionality. We think from the cosmological theory of the Big Bang, our universe started from a singularity which means there was a spacetime when spacetime did not exist at all. A singularity would be pure chaos where spacetime and information would be

meaningless. It would not be nothing and it would not be something, it would be indefinite and indeterminate. Chaos is a very ancient notion.

> Hesiod's Theogony (8th-7th century BC) was the first attempt to synthesize these traditions, which probably dated back to the Assyrian and Babylonian civilizations. In recounting the stages in the emergence of the gods from primordial chaos, Theogony offers an answer to the eternal questions of cosmogony: who created the world; what were the basic materials from which it was made; which came first, the gods, the stars or the elements? Not only did Theogony have a strong influence on Greek thought, it also anticipated in some ways today's theories of the origin of the world - particularly the idea of primordial chaos. Since the universe appears to have an ordered structure (albeit an imperfect one), it seems logical to regard the state which preceded the Creation as one of disorder and confusion. This notion has provoked greater controversy than almost any other in the history of cosmogony.[249]

I want to note here that in the statement, '*it seems logical to regard the state which preceded the Creation as one of disorder and confusion*' that of course disorder and confusion are oppositional to 'logical' by definition, so the 'controversy' is a faux argument. 'Order' necessitates '*disorder and confusion*' but must relegate '*disorder and confusion*' definitionally, epistemologically, not ontologically, as if it were purely a matter of existence or nothing. Nothing is not chaos. Nothing is a logical negation of something. Nothing is a determinate idea from the idea of something. Nothing only gains an apparent identity based on its opposite - something. Something can be God, creation, existence, Being, Concept, etc. Basically, everything which is not nothing can be something. Both something (what we define it as) and nothing are from the start

symbiotic ideas. They have an essential dependence on each other. The logic of nothing and something cannot have any meaning for chaos. The ancient notion of chaos is not logical in any sense. Chaos in the ancients came long before logic. However, it could be argued that this pre-history of chaos gave birth to logic, order, and sense. In the temporal transitions of the ancients and in the spookiness of quantum physics, chaos does not exclude such a birth as origin. It does not logically negate origin but only finds irrelevance to origin. In classicism, origin becomes but in quantum physics uncertainty has hazy relations with observations upon observations, updating information branches and flows which do not negate previous observations as much as move confluences of parallel information flows or more easily thought of as universes away from each other. This is called the quantum wave function.

The observer is not a subject or many subjects, but the wave function is caught up together with the (for lack of better word) universal 250 wave function. Physics refers to this as information. Information is not some version or metaphysic of 'reality'. In the wave function cause and effect are an information update which cannot yet find an order. It cannot be universal or absolute. Information cannot yet be the same or other. Even the notion of '*is*' *is* information which recoils upon itself. The idea of '*is*' and '*is not*' are logical negations of the first order. To equate '*is*' and '*is not*' as contradictory is already to assume identity and its opposite. We must use '*is*' to use language. Language affords us no other alternative. Information as causal flow 'is' infinitely regressive. Information recycles upon itself from the inescapable idea of, on one hand, information as both [causal, ordered] information and, on the other hand, as exformation which '*is*' and '*is not*' information. Current physics has exhausted and proven as much as anything can be proven in physics, that uncertainty and indeterminacy give rise to certainty, determinacy, cause and effect, logic, order, 'reality' in some spooky relationship with exformation. The intertwining of information and exformation can have no absolute or even relative

[as relativity]. It defies the '*is*' to the point where externality cannot yet '*be*' ascertained as opposed to internality. In the use of the term externality, we point not to nothing and not to something. Rather we point to the inability to be able.

Phenomenology in 20th century philosophy addresses the relevance of classical notions of 'reality' by asking us to simply observe not just what presents itself but **how** it presents itself. Phenomenological observation means simply looking at what presents itself in our lived experience without imprisoning phenomena in historic abstractions. I have discussed this in a previous post on Orwell and Levinas 251 and many other posts on my blog as well. As embodied humans we stand on the feeble precipice of knowledge. Physics as historically separated from philosophy is now coming full circle back to a more archaic and lost richness, A richness which now holds the promise of not returning to chaos but perhaps gaining a hint of a bygone epoch of what may have once been indicated by the terms ‘yawning gap’. The yawning gap at this point in the history of philosophy has the possibility of not being abducted by historic neutrality but allowing for the he or she which faces us in a very different way. If contemporary situatedness can allow us to behold the new richness of this precipice we might find a way into Ethics, responsibility for the other. Ethics which has rarely been given its saying and only covered over by what has been said.

We have seen how, without us being aware of it, modernity imposes an abstraction on our practicalities which reflexively defines 'reality' as subject and object existing as things in absolute time and space. We do this at the expense of our lived experience. Lived experience is dismissed as merely subjective. Lived time is ignored in favor of clock time. Lived space is thought in terms of linearity not lived regions we bring close and withdraw from. For example, how we inhabit the space of a cup of coffee we are drinking rather than the glasses on our face which are linearly closer to our eyes.

We have seen how exformation has a kind of externality which places a requirement on us. This externality cannot be captured by ready-made categories. What is more, this externality requires something from us. It requires us to continually check our reflexive understanding at the gap of an excess to our commonsense notions of 'reality'. What comes 'naturally' to us falls into a convenience of history which exformation no longer affords us. I have illustrated this unease as chaos, a yawning gap, which finds no rest in the absolutes of modernity. Now, in this section, I ask you to take this dynamic of an externality which we cannot reconcile or bridge over into any familiarities into Levinas' discussion of the other.

To be clear, I am going to use the word 'sensual' as the lived embodied experiences which we 'feel' practically on a daily basis, not just the restrictive form of sexual sensuality. Levinas asks us to take a phenomenological look at our sensual lived experience of the other to see if perhaps our historic practicality has enabled us to overlook something important about how we experience the other. Levinas grounds this experience in very practical ways in which we come face to face with the other. As a human, I am embodied. I do not just have modernity's senses as a thinking machine which takes in sense data. I have sensuality. My embodied sensibility comes before my thoughts which come in the form of reflection after the sensual encounter with the other. Here is where the experience of the other diverges from Exformation. Exformation is not a sensual experience of the other. However, I have used the discussion of exformation to illustrate something which I hope is more accessible to the reader. We think of physics as something 'real'. And now physics has arrived at a junction in history in which the 'real' has become problematic—essentially problematic. Now, I want to turn our attention to how we interact and reflect on our interactions with the other to see if something akin to the exteriority of exformation might be found in how we sensually experience the encounter with the other and what that may imply.

From the earliest Greek notion of *phusis* through its split into

physics and philosophy into the Latin reduction to nature one notion has been dominant and authoritative all the way through Western history - rule, authority, origin and birth are all thought together with Being. All the way back to my discussion about the inability of 'thinking' to think the informational thought of Entangled particles should tell us something, something very important. The awkward inability to be able, to have words or thoughts for thinking exformation, the ***is*** of exformation which cannot be in spacetime, in cause and effect, but yet shouts at us to pay attention. We can say what it isn't because language affords us the 'not', the negation. However, we cannot own it. We cannot find positive footing from our history which discloses, brings into presence, into light. We can describe entangled, informational behavior, as how two observers will see its spookiness and how we can build quantum technologies for incredibly new and promising ways of thinking but the '***is***' of our inheritance cannot rest easily in 'spooky-action-at-a-distance'. Why is that?

How can we speak about anything without naming subjectivity? This is a truism. Any conception must arise from a thinking subject. Kant has shown that thought *a priori* rises from Categories of Understanding. Only the 'thing-in-itself' is left to ponder subjectivity without objective Categories of Understanding. For Kant, phenomenality, existence, my lived subjectivity, arises from the object of thought, the Categories of Understanding. But what is identity for Kant?

Kant posits that a person possesses a unity of apperception, which means the ability to recognize oneself as a continuous, self-aware entity over time. This unity allows us to perceive our own identity through different moments and experiences. Kant acknowledges that we understand our identity through empirical criteria. These include sensory experiences, memories, and the continuity of consciousness. When we recognize ourselves as the same person who existed in the past, we rely on these empirical markers. Interestingly, Kant also acknowledges the rationalist

notion of identity. According to this perspective, identity is not solely dependent on empirical evidence. Instead, it is a necessary concept for practical purposes. While empirical criteria help us recognize our identity, the rationalist notion provides a foundational understanding that transcends specific experiences. Kant maintains that the rationalist notion of identity is “necessary and sufficient for practical use.” In other words, even though empirical evidence informs our daily understanding of identity, the rational concept of identity serves as a practical framework for moral responsibility, decision-making, and social interactions. Kant’s exploration of identity encompasses both empirical and rational dimensions, emphasizing the interplay between our lived experiences and our conceptual understanding.

> "For through the I, as a simple representation, nothing manifold is given; it can only be given in the intuition, which is distinct from it, and thought through combination in a consciousness. An understanding, in which through self-consciousness all of the manifold would at the same time be given, would intuit; ours can only think and must seek the intuition in the senses. I am therefore conscious of the identical self in regard to the manifold of the representations that are given to me in an intuition because I call them all together my representations, which constitute one. But that is as much to say that I am conscious a priori of their necessary synthesis, which is called the original synthetic unity of apperception, under which all representations given to me stand, but under which they must also be brought by means of a synthesis” 252

Kant’s apperception is the immediate “I think therefore I am” of René Descartes. But Kant tells us that apperception is not enough to explain identity. Therefore, the requirement for identity is self-awareness, self-consciousness. The self must have representations of

itself as an awareness of awareness. Here again we find the solitary substance of one without another. The self knows itself from itself. The other is a representation of self to itself. Identity once again effaces the relevance of the radical alterity of the other. 253

The notion of identity can only reverberate, replay itself endlessly in the mode of A = A, to own my being, my representation of myself to myself. My subjectivity must be swallowed up by the *a priori*. Forget about that messy little thing-in-itself behind the curtain in the Kingdom of Oz, of Being. Levinas tells us,

> Without resorting to the truism that all reality that is in any way recognized is subjective, a truism that goes with the one that says that everything that is in any way recognized presupposes the comprehension of being, Kant, by distinguishing in the course of the solution of the Antinomies the temporal series of experience from the in-temporal (or synchronic?) series conceived by the understanding of the other, has shown in the very objectivity of an object its phenomenality: a reference to the fundamental incompletion of the succession, and hence to the subjectivity of the subject. 254

Kant opposed the reduction of Hume to sensation and empiricism. Kant wanted to understand what was behind metaphysics. He tells us,

> "That the human mind will ever give up metaphysical researches is as little to be expected as that we should prefer to give up breathing altogether, to avoid inhaling impure air. There will therefore always be metaphysics in the world; nay, every one, especially every man of reflection, will have it, and for want of a recognized standard, will shape it for himself after his own pattern. What has hitherto been called metaphysics, cannot satisfy any critical mind, but to forego it

> entirely is impossible; therefore a Critique of Pure Reason itself must now be attempted or, if one exists, investigated, and brought to the full test, because there is no other means of supplying this pressing want, which is something more than mere thirst for knowledge." [255]

Kant in his Critique of Pure Reason used reason itself to determine its own limits as in the Categories of Human Understanding. Sensation was the raw data which was necessarily always filtered *a priori* by the Categories. We could never understand 'reality' itself, the thing-in-itself except from the Categories.

> Much of the difficulty in Hegel's work stems from his purpose: he sought to dismantle a monumental work of philosophy, Immanuel Kant's Critique of Pure Reason (1781), where Kant used reason to determine its own limits. Our senses are bombarded with stimuli – raw data which our minds receive and shape and organize, creating our perception of reality. There is an objective reality out there, which Kant called the 'thing-in-itself'. As we can't access that reality directly, but only filtered through our perceptions, the 'thing-in-itself' is beyond the scope of science and even reason, so it will forever be a mystery. Despite this, Kant knew that the mind thirsts for ultimate reality: "That the human mind will ever give up metaphysical research is as little to be expected as that we should give up breathing," he wrote. Hegel set out to prove Kant wrong. Like his contemporaries Fichte and Schelling, he felt that philosophy could find and understand Kant's thing-in-itself. [256]

Hegel thought that Kant stopped short at the thing-in-itself. The thing-in-itself was yet another metaphysics. It was a metaphysics of negation. For Hegel, metaphysics was the desire for subjectivity to

possess, to own, its object, to find how it was ultimately the subject of all predicates. Therefore, according to Hegel, subject and object define each other. They are the same thing and are therefore, lifted up as self-consciousness in Hegel's work entitled, "The Phenomenology of Spirit". However, in Hegel's Jena Lectures (1805-1806),

> What is posited thereby is the concept of freely interrelated self-consciousnesses – but only the concept itself. Since it is only a concept, it is still to be realized; i.e., it is to transcend (aufzuheben) itself in the form of a concept and approach reality, in actuality, it itself occurs unconsciously in the dissolution of the problem and in the problem itself – unconsciously, i.e., so that the concept does not intrude into the [realm of the] object. 257

Hegel tells us that Kant's work failed to arrive at the object, the universality of Concept. Some Hegelian scholars tell us that the "Phenomenology of Spirit" could not account for the universality of absolute Spirit, that it could not arise to Concept merely from itself. Individual self-consciousness could not give us absolute consciousness. Consciousness could not admit an exteriority required for absolute Idea or Concept.

> To anchor idealism immanently--so that we need not appeal to an outside and thus undermine our idealism--we need resistant objects, which, as we have seen, theoretical reason gives us. Secondly, we need totality--the absolute. There can be nothing outside of consciousness--no outside to consciousness. Individual consciousness cannot give us such totality--an absolute consciousness will be required. 258

However, the "Phenomenology of Spirit" absolute consciousness was found to be lacking. Subjectivity is based on self-consciousness.

Even in absolute Spirit's negation of itself it cannot arise into universality. Self-consciousness cannot arise to an identity of absolute consciousness except in abstraction where essence as time would have to turn back on itself. The multiplicity of self-conscious subjects would have to combine to achieve a universal self-consciousness of the mind. But negating a multiplicity of individual self-conscious subjects to achieve universal self-consciousness would be like "*bits of dust collected by its movement or drops of sweat glistening on its forehead because of the labor of the negative it will have accomplished. They would be forgettable moments of which what counts is only their identities due to their positions in the system, which are reabsorbed into the whole of the system*". Hegel finds this unacceptable as he always wants to move from abstractions to more concrete dialectics. Levinas writes,

> The reduction of subjectivity to consciousness dominates philosophical thought, which since Hegel has been trying to overcome the duality of being and thought, by identifying, under different figures, substance and subject. This also amounts to undoing the substantivity of substance, but in relationship with self-consciousness. The successive and progressive disclosure of being to itself would be produced in philosophy. Knowing, the dis-covering, would not be added on to the being of entities, to essence. Being's essence carries on like a vigilance exercised without respite on this very vigilance, like a self-possession. Philosophy which states essence as an ontology, concludes this essence, this lucidity of lucidity, by this logos. Consciousness fulfills the being of entities. For Sartre as for Hegel, the oneself is posited on the basis of the for-itself. The identity of the I would thus be reducible to the turning back of essence upon itself. The I, or the oneself that would seem to be its subject or condition, the oneself taking on the figure of an entity among entities, would in truth be reducible to an abstraction taken from the

> concrete process of self-consciousness, or from the exposition of being in history or in the stretching out of time, in which, across breaks and recoveries, being shows itself to itself. Time, essence, essence as time, would be the absolute itself in the return to self. The multiplicity of unique subjects, entities immediately, empirically, encountered, would proceed from this universal self-consciousness of the Mind: bits of dust collected by its movement or drops of sweat glistening on its forehead because of the labor of the negative it will have accomplished. They would be forgettable moments of which what counts is only their identities due to their positions in the system, which are reabsorbed into the whole of the system. 259

But Hegel wants to take away the substantive from absolute. Substance all the way from the Latin transformation and deformation of *ousia* build on the notion of abstract stuff, matter, body in binary opposition to mind. Therefore, Hegelians have argued that the use of the word 'absolute' does not designate a non-relative essence but rather simply a relative position within Hegel's progression. Cambridge published a book entitled, Hegel's "Philosophy of Spirit", where the author Angelica Nuzzo challenges what could possibly be meant by such a subtlety of nuance in thinking of the absolute.

> I have argued that contrary to what many interpreters seem to assume, there is simply no original, substantive "Absolute" in Hegel's philosophy, but that the adjective "absolute" (along with the adverb) is instead a systematically crucial, topological predicate that indicates the "place" or position of a certain determination or concept (and its reality) within the overall structure of philosophical thinking. Moreover, this position is not a static point or marker within a given whole but is rather a dynamical stage in the process through

> which the whole of philosophy is first constituted in the form of a complete system. This is, to be sure, the first step in a broader discussion that leads to the further question of what warrants the designation of “absolute” for a certain moment within such a process. In other words, what is it that makes a certain moment at stake at a specific stage of the systematic constitution of the whole of Hegel’s philosophy an “absolute” moment? And, furthermore, is the “absoluteness” of all “absolute” structures and concepts the same? 260

In naming ‘universal’, Is Hegel hierarchical or temporal? If not, what is meant by the absoluteness of absolute? Is universal just a shortened name for a particular movement otherwise called ‘Concept’? I think we need to look at how absolute Spirit, self-consciousness’ concrete fulfillment of itself juxtaposed to the other. to otherness, universalizes. Absolute Spirit must be itself by its other, absolute otherness. Absolute spirit cannot pull itself up by its own bootstraps. It needs what is not itself to become something other than itself. Exteriority to self-consciousness raises them both up to Concept.

> According to Hegel, the relationship between self and otherness is the fundamental defining characteristic of human awareness and activity, being rooted as it is in the emotion of desire for objects as well as in the estrangement from those objects, which is part of the primordial human experience of the world. The otherness that consciousness experiences as a barrier to its goal is the external reality of the natural and social world, which prevents individual consciousness from becoming free and independent. However, that otherness cannot be abolished or destroyed, without destroying oneself, and so ideally there must be reconciliation between self and other such that consciousness can “universalize” itself through the other. 261

So universal Idea is the subject from which all predicates proceed not a metaphysical monad. But in order for self and other, interiority and exteriority, to rise above themselves, exteriority has to lose its radicality. In this case, exteriority can only be what it is by opposing subjectivity. This is a binary duality which can have no excess but only a resolve, a completion, a universal essence which we are led to believe still hold the interiority of the subject and the exteriority of the object, the other, together in their difference to each other. Concept cannot be Concept without other. Nor can Concept be Concept with the completion of self-consciousness in absolute Spirit. Can we detect a shift in what is meant by exteriority? In this case exteriority has no excess to the same of self-consciousness. Exteriority is made logically commensurate with its dialectical opposite. The other must oppose self-consciousness as what self-consciousness cannot know, must always reside as the binary duality of knower and known. There is no excess here for exteriority only a 'not' which must fill the place, mark the *telos* and completion of exteriority. But is that the sum of everything meant by exteriority? Well, at least quantum physics would differ on that point as we have seen. In dominant strains of classical narratives of philosophy and science the self, knowing, Concept, time and space, cause and effect, locality as mechanism must always cover over the ancient intuitions of chaos, lack of origin, and exteriority. Exteriority must always bow to the rule of origin to be recaptured, recuperated, reduced into the 'not' of knowledge, essence, and truth.

> But is subjectivity thus conceived in what is irreducibly its own? Hegel and Heidegger try to empty the distinction between the subject and being of its meaning. In reintroducing time into being they denounce the idea of a subjectivity irreducible to essence, and, starting with the object inseparable from the subject, go on to reduce their correlation, and the anthropological order understood in

these terms, to a modality of being. In the Introduction to the Phenomenology of Mind, in treating as a "pure pre-supposition" the thesis that knowing is an instrument to take hold of the Absolute (a technological metaphor) or a medium through which the light of truth penetrates the knower (a dioptic metaphor), Hegel denies that there is a radical break between subjectivity and the knowable. It is in the midst of the Absolute that the beyond takes on meaning; essence, understood as the immanence of a knowing, is taken to account for subjectivity, which is reduced to a moment of the concept, of thought or of absolute essence. Heidegger says, in a remark at the end of his Nietzsche (Vol. II, p. 451), that the "current term subjectivity immediately and too obstinately burdens thought with deceptive opinions that take as a destruction of objective being any reference from Being to man and especially to his egoity." Heidegger tries to conceive subjectivity in function of Being, of which it expresses an "epoque": subjectivity, consciousness, the ego presuppose Dasein, which belongs to essence as the mode in which essence manifests itself. 262

In classical narrative the 'not' of life, death, has become the marker for necessity to overcome, to conquer, to raise its pitch to the heights of Zarathustra's tragic mount. For Heidegger, authenticity begins when we resolutely accept that we are always on a journey toward our own death. Our own death is something that no one else can experience for us. Heidegger refers to this as being-towards-death. It is in this acceptance that authentic Being is disclosed. Facing death as mine opens up the question of Being itself. Authenticity resolutely arises when we accept and endure our own mortality rather than concealing it in the they-self, *das man*. 263

In our preliminary existential sketch, Being-towards-the-end

has been defined as Being towards one's ownmost potentiality-for-Being, which is non-relational and is not to be outstripped. Being towards this possibility, as a Being which exists, is brought face to face with the absolute impossibility of existence. Beyond this seemingly empty characterization of Being-towards-death, there has been revealed the concretion of this Being in the mode of everydayness. In accordance with the tendency to falling, which is essential to everydayness, Being-towards-death has turned out to be an evasion in the face of death—an evasion which conceals. While our investigation has hitherto passed from a formal sketch of the ontological structure of death to the concrete analysis of everyday Being-towards-the-end, the direction is now to be reversed, and we shall arrive at the full existential conception of death by rounding out our Interpretation of everyday Being-towards-the-end…

The full existential-ontological conception of death may now be defined as follows: death, as the end of Dasein, is Dasein's ownmost possibility—non-relational, certain and as such indefinite, not to be outstripped…

Death is Dasein's ownmost possibility. Being towards this possibility discloses to Dasein its ownmost potentiality-for-Being, in which its very Being is the issue. Here it can become manifest to Dasein that in this distinctive possibility of its own self, it has been wrenched away from the "they". This means that in anticipation any Dasein can have wrenched itself away from the "they" already. But when one understands that this is something which Dasein 'can' have done, this only reveals its factical lostness in the everydayness of the they-self.

The ownmost possibility is non-relational. Anticipation allows Dasein to understand that that potentiality-for-being in which its ownmost Being is an issue, must be taken over by Dasein alone. Death does not just 'belong' to one's own

> Dasein in an undifferentiated way; death lays claim to it as an individual Dasein. The non-relational character of death, as understood in anticipation, individualizes Dasein down to itself. This individualizing is a way in which the 'there' is disclosed for existence. It makes manifest that all Being-alongside the things with which we concern ourselves, and all Being-with Others, will fail us when our ownmost potentiality-for-Being is the issue. Dasein can be authentically itself only if it makes this possible for itself of its own accord…
>
> The ownmost, non-relational possibility, which is not to be outstripped, is certain. The way to be certain of it is determined by the kind of truth which corresponds to it (disclosedness). The certain possibility of death, however, discloses Dasein as a possibility, but does so only in such a way that, in anticipating this possibility, Dasein makes this possibility possible for itself as its ownmost potentiality-for-Being. The possibility is disclosed because it is made possible in anticipation. To maintain oneself in this truth—that is, to be certain of what has been disclosed—demands all the more that one should anticipate. 264

According to Alexander Kojeve, a thinker deeply influenced by Hegel, death occupies a central place in Hegel's philosophy. For Hegel, acknowledging our own mortality is essential for authentic existence. Without death, we wouldn't be true individuals, free agents, or historical beings. Hegel saw death as a manifestation of negativity. He believed that man's death is essentially voluntary, arising from risks willingly taken. In this view, death is not merely a biological event but a conscious choice. Hegel described humanity as "that night, that empty Nothingness," containing an infinite number of representations. The night of the world, the intimacy of Nature, and the pure personal-Ego all converge in this existential darkness. In his Philosophy of Right, Hegel argued against the right

to suicide. He considered it a contradiction, asserting that there is no inherent right over one's own life. Interestingly, it would seem to be a contradiction to argue there is no inherent right to suicide and at the same time argue that death is as much a conscious choice as a biological event. Hegel's engagement with death extends beyond mere mortality—it touches on the essence of Being, authenticity, and the human condition. [265]

History must paint over death with a brush of redemption or unredeemable, the moment which leads to meaning or the moment which must be meaningless. There is a covering over of alterity in all these canopies upon which something must be drawn to fill the yawning gap. Exteriority must be settled, find fulfillment even if only by the marker of a tombstone. But every day, every moment of existence quantum physics tells us we fall from the exteriority of the spooky wave function which has an exteriority which cannot find meaning or meaninglessness, origin or the ''not' of origin, truth or falsity, authenticity or inauthenticity, all the permutations resulting from and in Concept and its absolute which must always overcome its 'not' without prejudice – from sheer logic. Seneca tells us, "*We suffer more in our imagination than in reality.*" The permutation of Oscar Wilde and George Bernard Shaw tells us, "There Are Only Two Tragedies. One Is Not Getting What One Wants, and the Other Is Getting It". [266] William Shakespeare, the master of human psychology and intricate character portrayal, explored the interplay between desire, drama, and reality in his timeless works. In "A Midsummer Night's Dream", Shakespeare deftly handles the theme of romantic desire that is prohibited by parents. When parents stand athwart desire, the forbidden nature of that desire makes it even more enticing. He illustrates this psychological truth through the play-within-the-play of "Pyramus and Thisbe". The myth of Pyramus and Thisbe, where young lovers defy parental prohibition to meet secretly, serves as a cautionary tale. Yet, ironically, it becomes the basis for the famous drama "Romeo and Juliet". True love remains attractive, even when it

meets a tragic end. Perhaps the very defiance against parental restrictions adds to its allure. René Girard, influenced by Shakespeare, observed a pattern in human desire. Rather than labeling it as “narcissistic,” Girard’s “mimetic theory” suggests that all desire is learned from others. The cases often diagnosed as “narcissistic” are better understood as “pseudo narcissism”, where mimetic interactions play a significant role. Desire, in its essence, is shaped by imitation and shared patterns of longing. Shakespeare’s characters, driven by desire, seek eternity. Even when love meets tragedy, as in “Romeo and Juliet”, the names of the ill-fated lovers are immortalized. Their early demise becomes part of the appeal—a defiance against mundane calculations and a testament to the power of love. Drama, with its portrayal of desire, captures the essence of human existence, transcending mere reality. Shakespeare recognized that our yearning for drama often surpasses the boundaries of everyday life. Through his plays, Shakespeare explores desire, authenticity, and the eternal human spirit on the grand stage of existence. 267

At this point I want to make a brief remark about il y a, ego, and the self. None of these topics should be thought of as somehow different ‘states of being’ or in some unspecified way different from each other. It is better to think of these capacities as relationships like onion skins, as all playing together in the ‘who’ of me.

The echo of Narcissus is not a solitary voice. Echo resounds from the innumerable canyons of a play named History. All the actors get reduced to ‘me here now’ in commonsense, in relationships which embody all the ambivalences love, desire, alienation, the bad intent and threat of the other, the irrelevant, alien, remote, the played and the player, danger, evil, God, nothingness all captured in the service of the ‘my’ of self. It is the voice of historic branching which must raise existence to its highest crescendo where the gift it brings is drama. Drama exacerbates and annihilates exteriority. It assumes too much, dares too much, resounds as known and the ‘un’ of known. The branching of fictions all devised to block off, alter,

what faces us, what exceeds us, what is unable to be able. This is not gnosis or a-gnosis (agnostic), knowledge or no knowledge (the 'not' of knowledge). Gnosis is a feminine Greek noun which means "knowledge" or "awareness". [268] Think of the quantum wave function which cannot easily find a 'place to be'. It is an excess which has no accounting. And 'it' is not an 'it'. The 'it' of history is the other who faces us which finds no place in echo and drama. The self must flee into origin, being, history to evade, the indeterminate in immersion of drama, sensuousness. The ego, the alter of ipseity, must inhabit itself, be at home with itself. The 'willing it thus' must arise in drama and sensuality. It must sooth itself in the refuge of historic voice and echo. The other is reciprocity to me as transactional. "*To present the knot of ipseity in the straight thread of essence according to the model of the intentionality of the for-itself, or as the openness of reflection upon oneself, is to posit a new ipseity behind the ipseity one would like to reduce."* (Levinas, Otherwise Than Being or Beyond Essence, 1981, p. 203)

> The unjustifiable identity of ipseity is expressed in terms such as ego, I, oneself, and, this work aims to show throughout, starting with the soul, sensibility, vulnerability, maternity and materiality, which describe responsibility for others. The "fulcrum" in which this turning of being back upon itself which we call knowing or mind is produced thus designates the singularity par excellence. It can indeed appear in an indirect language, under a proper name, as an entity, and thus put itself on the edge of the generality characteristic of all said, and there refer to essence. [269]

The oneself does not rest in peace under its identity, and yet its restlessness is not a dialectical scission, nor a process equalizing difference. Its unity is not just added on to some content of ipseity, like the indefinite article which substantifies even verbs, "nominalizing" and thematizing them. Here the unity precedes

every article and every process; it is somehow itself the content. Recurrence is but an "outdoing" of unity. As a unity in its form and in its content, the oneself is a singularity, prior to the distinction between the particular and the universal. It is, if one likes, a relationship, but one where there is no disjunction between the terms held in relationship, a relationship that is not reducible to an intentional openness upon oneself, does not purely and simply repeat consciousness in which being is gathered up, as the sea gathers up the waves that wash the shore.

The ego is not in itself like matter which, perfectly espoused by its form, is what it is; it is in itself like one is in one's skin, that is, already tight, ill at ease in one's own skin. It is as though the identity of matter resting in itself concealed a dimension in which a retreat to the hither side of immediate coincidence were possible, concealed a materiality more material than all matter —

> a materiality such that irritability, susceptibility or exposedness to wounds and outrage characterizes its passivity, more passive still than the passivity of effects. 270

In the retreating ego it imagines itself in the drama of origin, self as origin, which must rule and reign lest the eternal night overtake it. This night, the il y a, must be flooded with certainty pronounced in praxis 271, perchance to dream as 'daily life'. Physics has brought us before a gap, a void, a chasm which brings us towards a spooky alterity which has no home or place to lay its head in history. Levinas brings us before a radical alterity which finds no home in all our echoes. The inability of the self to be able, to be at home in itself, to root itself, branching rhizomic chaos pre-intentional sensuous lapse falling together with saying which must be forgotten in order to viscerally re-member it as the said, historic narrative taken up in echoing 'me'. The retreat to echo, to forget the lapse of interruption of saying, of exteriority before 'I' can gather into egoity foregoes ipseity, the naked bare self fleeing chaos, awareness not yet

constituted with awareness of awareness. The lapse of time between the pre-intentional sensuous moment and its intentionalization denotes the transcendence that Levinas also equates with "the Saying".

His discussion of the Saying correlates with his treatment of sincerity, introduced already in Existence and Existents. Otherwise than Being radicalizes his notion of sincerity, insisting that the structure of sensibility is always as if punctuated by sensuous lapses. It is thanks to such time lapses that we are open and able to communicate because, as we have seen, proximity is an affective mode that motivates dialogue. While all sensuous lapses are not necessarily openings to intersubjective communication, proximity and vulnerability are the loci of transcendence-in-immanence and the birth of signification (whether words are actually uttered or not). For Levinas, there is more in living affectivity than Heidegger's conception of being speaking through language captured. This is clear the moment we understand signification originally as an affective proto-intentionality and not as some thought, already formulated, that the I thereupon chooses to communicate to another. 272

Sensibility is punctuated by sensuous lapses. Sensibility rises from sensuous lapses. We first encounter the world sensually and then bring them into historic narrative as if that endows sensuousness with origin, the Idea of right exercised by free will. We authenticate our lived experience with right [*Recht*] in the field of freedom. It is as if embodiment is an after-glow of idea. In this case Idea must ever after cover over its in-adequation as the never-ending toil of Sisyphus who must eternally push a stone uphill only for it to once again fall back to the earth. Embodiment is diachronous to idea – meaning, not temporally synchronized to idea. An unaccounted-for excess interrupts us sensually in our embodiment before Idea claims its right in the freedom of a self. As such, the other as unaccounted-for externality is anarchic. It resists synchronization to my lived time. To the classical idea of universal

time. In anarchic externality, the saying of the other speaks from a lapse to my sensuality, from a radical alterity of externality. As embodiment, my lived sensibility, the saying of the other is from a time not my time which can only be made adequate to my idea by force as branching from classical narrative as the field of freedom in which my idea finds origin.

However, saying like exformation is not caused by or a result of origin. As diachronous, the other is not embodied in my lived time and space but speaks from an externality which is unequivocal to me. Saying is the "lapse of time" between "the pre-intentional sensuous moment" and Husserl's intentionalization into voices of consciousness. Embodiment branches from the lapse of radical externality which must retreat affectively before alter-ipseity can take hold as affective ego and become self from which idea, commonsense, understanding and knowledge can rule. The radical externality of the other addressing me is pre-intentional, pre-originary to my sensual lived time and lived space.

Saying as pre-intentional sensuousness falls together as historic retreat from the radical alterity of the face-to-face encounter with the other. Classical narratives as time and space come with historic, cultural, linguistic abstractions such as linear space and clock time. Even physics since Einstein has clearly shown that these notions come from history and classic physics before the advent of relativity. Absolute time and space are an abstraction not only to my sensuous experience of time and space but is also alien to the common-sense notions of absolute time and space which we have internalized from history and language. This is not philosophy telling us about classical narrative of time and space. This is physics which has unorthodoxly pulled these historic notions out from under our feet. We can remain in ever growing vacuous abstractions of idea, in history, or we can seriously consider the notions even implied by relativity. It might be interesting to note that agrarian time has been translated to clock time as linear 'now' moments where technology has moved our sense of time from years and days

toward seconds and milliseconds. Entanglement is perhaps analogously similar to Levinas' notion of the alterity of the other with one very fundamental exception. Instead of exformation, embodiment would require our analogy to utilize the concept of singularity, the analogously 'ex' of exformation. We will refer to this as Levinas does as radical alterity or the Other as designated by a capital 'O'.

> For Levinas, the oneself may indeed appear as a faceless neutrality, "on the edge of the generality characteristic of all said," but this appearance is already a mask covering its "nameless singularity" (OB 106), its recurrence as a point of identity bearing alterity. This nameless singularity is irreducible to being, but it also inscribes itself as a trace in the midst of being; it borrows a name from being in order to show itself in the said, in order to matter in the world, and not just in the pure elsewhere of pre-originality—wherever and whatever that may be. However, this name of being is only a mask which is constantly unmasked, or unsaid, in its singular exposure to the Other. To repeat the formulation with which I began this paper: Anyone is responsible for any Other who happens to come along. The indeterminacy of the interval in the instant of hypostasis provides a logic for articulating selfhood as the Other-in-the-same, both separate and responsible, different and exactly equivalent to Others; it allows us to describe how the self remains itself (or, more exactly, becomes itself) while substituting for the irreplaceable, non-exchangeable Other. 273

For Levinas, singularity as absolute uniqueness does not happen in a vacuum. Its actual uniqueness consists in its oscillation and confluence of the saying and the said. The lapse discussed earlier in the encounter with the other which Levinas refers to here as saying is not in my lived time and space. Phenomenology, postmodernism,

and even analytic philosophy in the 20th century along with quantum physics are all exposing insufficiencies with classical narratives. The exteriority of the wave function and chaos find synergies with how we live physics, space and time, historic narratives of language, and the linguistic turn in analytic philosophy. For Levinas the encounter with the other is a rupture of externality in the saying, a lapse, not yet made commensurate by history and narrative nor even to the sensual, feeling, 'me'. But in the interruptive 'branch' I first live the after effect of the externality of the other as embodiment. In the clash of my lived time and space and unaccounted-for externality of the other cannot be made congruent with me except in a mask, a façade of the same, the echo of classicism on Being and Idea. For physics, a singularity is exformation caught up in the exteriority of the wave function which can no longer be thought of as spacetime but rather information which passes into chaos, without organization, without classical science and historic narrative. In Levinas' notion of singularity, the "*indeterminacy of the interva*l" is a lapse of exteriority which cannot be made classical or commensurate with me in 'my reality'.

> The phenomenology of internal time consciousness explained the past entirely by this retentional effort; the past is the represented, by recall and first by primary retention; it is held by the force of the present. In principle everything is retained, and still recoverable, representable. Yet the past passes, and passes of itself, irretrievably. There is loss, falling away irrevocably, lapse of time. The bond with the past is a bond with a dimension of oneself which one cannot regain possession of once more, which prevents complete self-possession — and which yet holds on to one, holds one like a bond. Ageing is this temporalization — by virtue of the temporalization of one's time, one is being carried beyond one's powers. 274

The interruption of temporality by externality cannot be temporalized. It cannot be measured or spanned.

> It is then the temporalization of time, in the way it signifies being and nothingness, life and death, that must also signify the beyond being and not being; it must signify a difference with respect to the couple being and nothingness. Time is essence and monstration of essence. In the temporalization of time the light comes about by the instant falling out of phase with itself — which is the temporal flow, the differing of the identical. 275

But time and distance as life must arise again into being and existence as if there were no lapses, as if non-existence could only be classical and metaphysical. In the branch from exteriority, we first live the other, being with the other as embodiment which even then, cannot yet be reduced to the idea of the other, to the monstration of essence. From embodiment yet once again, there is difference which must be rescued and accounted for by difference.

> When stated in propositions, the unsayable (or the an-archical) espouses the forms of formal logic; the beyond being is posited in doxic theses, and glimmers in the amphibology of being and beings — in which beings dissimulate being. The otherwise than being is stated in a saying that must also be unsaid in order to thus extract the otherwise than being from the said in which it already comes to signify but a being otherwise. Does the beyond being which philosophy states, and states by reason of the very transcendence of the beyond, fall unavoidably into the forms of the ancillary statement? 276

As embodiment, we branch into the said. We are spoken to by radical exteriority. We are called by the singularity of the other, in

speaking to us. Always before we can retreat from him or her, we are taken captive from a radical exterior which can only find retreat from difference as the same. The saying of the other as singularity which our sensualness finds no lived place or time for reflexively pushes us away from the other into Being, logos, and historic self-interest. Difference raises itself into Being as Idea. Here the echo resounds, the same yet different. Once again, for the first time, we step into the light of reason, the most common of sense, the moment of the Big Bang which can only be reckoned afterwards, where time zero is never found only the spirit of gravity in Idea must fall again from many-worlds. “I think; therefore I am.” This idiom exposes the bare certainty of origin in modernism. But the gravity of idea is lived as experience, as affect-weighted attraction in which presence and idea bobble on the surface of lived experiences. This is where we saw earlier where embodiment, idea, and neutrality as modes of lived presence and absence find their way into phenomenology.

The way I think about phenomenology is as Einstein’s relativity. For the most part, relativity sees no breaks in spacetime. Sure, the curvature of spacetime is deformed by mass but for the most part transitions are smooth and continuous. A singularity in general relativity is a ‘metaphysical’ break in spacetime, a rupture which most relativistic physicists understand a point in the theory which does not make mathematical sense. It is relegated to ‘something we do not understand yet’. But for quantum physics breaks in spacetime are the rule rather than the exception. So, a singularity is simply the bare exposure of spacetime as exformation which is not exceptional to spacetime but spacetime is probably emergent from exformation as the quantum wave function. Likewise, phenomenology does not see breaks in lived phenomenon. We live transitions in phenomena experientially analogous to smooth transitions of spacetime distortions by mass. But ruptures in phenomenology like the lapse of radical exteriority for Levinas cannot exist except as abstraction, metaphysics. But the observer

effect in the branching of the wave function has also met with such abrasive skepticism early on. Even the inventor of relativity could not abide the spooky of quanta and spent decades trying to find a classical answer in locality and unified field theory. Postmodernism has also found breaks in linguistics and language which have incurred the wrath of unmitigated obscurity and merely language games. All of this as species threats of extinction in climate change and nuclear weapons with authoritarianism on the rise indicate a kind of sociological existential crisis. Even Levinas has not been unscathed by criticisms of the radical alterity of the other. This comes in the form of what we think of as the 'bad faith other'.

The popular notion of 'othering' someone as making them not like me and therefore less than me is a misnomer or the wrong name applied to a certain behavior. The name which should be used in this case is sameness, making someone the same as my idea of them. This is exactly what Levinas counters. Levinas calls 'othering' someone totalizing them, making them the same as my idea of them, e.g., lazy, inferior, stupid, sinner, evil, etc. We need look no further than the extreme right's catch all word for everything they do not like in the absurdly misunderstood term, 'wokeness'. There is no sense of otherness in their use of 'wokeness' since there is no other in their use of the term. 'Othering' in this sense is only a monologue with oneself. It has nothing to do with an 'other' apart from me and my idea. Levinas would call this violence towards the other or more precisely the murder of the other. This is what he means by totalizing the other - leveling them off to my idea of them.

African Americans have been using the term ‘woke’ for generations in the United States. Women in the United States just got the right to vote one hundred years ago. Feminism made explicit what many women encounter in a world dominated by men. Ethnic minorities have encountered obstacles of discrimination and inequality. Lesbian, gay, bisexual, transgender and queer are harassed and are victims of violence. In a

phenomenological sense, this demonstrates the violence of suspending our individual phenomenal experiences of the world in favor of despotism rising from a frantic, fanatical feverishness marking the exasperated pleas as a bygone dominant universal epoch of righteous claims of rule and origin at any cost including horrific violence and extermination of evil others. In mental psychosis evil others and voices pop up magically. We are seeing this on a worldwide sociological level now. It is as if sociologically, unconsciously we cannot tolerate the possibilities given by a dying history taken as the 'not' of order, disorder, the bad faith other of order as maddening chaos. All of this is group psychosis in which externality must be quashed at any cost.

The reactionary movement we are currently experiencing in the political right in our country is a desperate and futile attempt to force and give artificial life-support to universal narrative of a fading age, an epoch, which can no longer sustain civilization. While relativity was rattling the cages of classic physics in the early 20th century, phenomenology was asking about the concrete ways we live 'reality'. Phenomenology was asking why we downplay our personal experiences over the dominant cultural narrative of commonsense neutrality and transactionalism. For Husserl, the point of phenomenology was to seek what was the truth of personal or 'local' experience. The word 'veridical' means truthful, genuine, not illusory.

> A perfect hallucination is one that is indistinguishable from a veridical perceptual experience. In principle, for every possible veridical perceptual experience there is a corresponding hallucination that cannot be distinguished from it. Nothing about the experience gives it away as non-standard in any respect. 277

Husserl stood at the precipice of the oncoming abyss in the early 20th century. He understood the approaching storm which would

undermine centuries of historic narrative. His strategy was cooler heads prevail. Let's stop, *epoché*, bracket and reevaluate.

> The point of the local epoché can perhaps best be brought out if we follow Husserl in applying it to the case of perceptual experience. The phenomenologist is supposed to perform his or her descriptions from a first-person point of view, so as to ensure that the respective item is described exactly as it is experienced.[278]

Phenomenology in a relativistic sense asks the truth of how the individual experiences phenomena. It also brings into question the universal validity of our current epoch. The inability of Being and essence to be 'in itself' is already an announcement of the end of our current classical epoch. There is no going back to reinstate a dying epoch. Philosophy and physics have become the voice of the modern-day prophet. The road ahead can only lead to extinction in the war of all against all. In the 19th century, Nietzsche prophetically saw the approaching storm which required a reevaluation of all values. However, he failed to gain clarity as to how that would happen and what it would mean. His idea was a restart of the greatness of the ancient Greeks. He saw this as the Übermensch, the superman, the ascending life of the 'new *man*'.

> Elevated is then your body, and raised up; with its delight, enraptureth it the spirit; so that it becometh creator, and valuer, and lover, and everything's benefactor.
>
> When your heart overfloweth broad and full like the river, a blessing and a danger to the lowlanders: there is the origin of your virtue.
>
> When ye are exalted above praise and blame, and your will would command all things, as a loving one's will: there is the origin of your virtue.
>
> When ye despise pleasant things, and the effeminate

couch, and cannot couch far enough from the effeminate: there is the origin of your virtue.

When ye are willers of one will, and when that change of every need is needful to you: there is the origin of your virtue.

Verily, a new good and evil is it! Verily, a new deep murmuring, and the voice of a new fountain!

Power is it, this new virtue; a ruling thought is it, and around it a subtle soul: a golden sun, with the serpent of knowledge around it. 279

This is a clear statement of Nietzsche's echo back into himself. Nietzsche is the pinnacle of "I am that I am". This is not to imply a religious criticism. This is a criticism and iconoclasms of classicism's inability to recognize the higher man. This is the self as self-made, the self as god-like from Nietzsche's ancient Greek exaltations. But this is not a novel as Nietzsche pretends. This is the ancient path of Narcissus.

Substitution

This section will eventually get into some more difficult examinations of Levinas' writings on substitution. If you find it too difficult, I will return to it later with a simpler explanation in the last section entitled "Ethics and Love". I want to take a step back at this point to try to get some perspective in preparation for this section. I spent a lot of time on the quantum wave function trying to illustrate a couple main points. The first point is that most folks generally have a lot of confidence in science for good reasons. And in the 20th century science really jumped off a cliff no matter how some would like to restate that point. The geniuses who discovered quantum physics and their predecessors have amply written and publicly spoken about the devastating consequences to classical science and philosophy from their discoveries. Certainly, there is a

way quantum physics seeks after and finds how classical science can be accounted for in limited cases of quantum physics, but this is not business as usual. There is an exteriority to exformation and the quantum wave function which cannot be tamed by classicism. And this demands the same focus on exteriority from philosophy. The 20th century is a case and point for how philosophy has grappled with the erosion of its certainties. The second point is since we can have confidence that there is much more under the surface of 'reality' than we ever thought there was from classical history. We cannot partition off our macro world as if it was self-evidently distinct from what quantum physics is telling us. Quantum physics has already made inroads into the macro world benefiting humanity in many ways. If *Homo sapiens* can survive long enough there is every reason to believe that we, as self-conscious, may have some spooky connection to the chaos and uncertainty of quantum physics. In any case, whatever comes out of all this in that regard, most of us will not be around when those discoveries come into fruition. So, some of us that are not in the business of physics would like to try to intuitively make some sense out of what phenomena are telling us. We know that a very different philosophy is implicated by 20th century quantum physis. What seems most certain is that alterity lies beneath the covers of 'reality' and it affects us – who we think we are, what 'are' *is,* and unavoidable responsibility implicated from the vantage of our standing on this historic precipice.

With that in mind, Levinas tells us that radical exteriority faces us every day. Specifically, Levinas tells us the other is not the echo of our ideas of the other but very different. We also know the philosophical tradition of essence, whether determined in classical or modernist narratives, has serious deficiencies in what quantum physics is showing us. I have tried to be very careful to use the word 'analogy' when discussing issues between philosophy and quantum physics which may impact each other and especially in regard to Levinas' idea of the alterity of the other. To imply that my

associations in this regard are true or certain would be ludicrous. Might there be a science/philosophy connection between quantum spookiness and the he or she who faces us? Certainly, but one key point quantum physics plainly tells us is that 'certainty' is not what it pretends and what we simply assume it *is*. However, I think there is an intuitive feeling that there must be something to all this philosophically. There are little direct written connections between postmodern philosophy, Levinas, and quantum physics. However, just as the tree of life myth grew up pluralistically in very ancient cultures so too have odd associations grown between 20th science and philosophy. Mostly, Levinasian scholars base their research on the history of philosophy which led up to Levinas. So, to imply that what Levinas is telling us that quantum physics is telling us something about quantum physics would be wrong. There are many differences which cannot be made commensurate. In the next few sections I plan to bring out some of these differences in Levinas.

To start the discussion of Levinas' idea of substitution I want to briefly give some context to this. Let's recall the various ways the radically exterior of the he or she who faces us gets leveled off and effaced from historic narrative which has found its way into practical everyday common sense assumptions such as:

- 'We are all the same and/or different' where 'different' here implies the bad faith echo of the 'other' which is not the other at all only my idea of the other.
- 'It's me for or against them' which I referred to as transactionalism coming from the self of echo.
- We are all merely machines whether that is modernism, reductionary evolution, merely biological, God's children, or all the other ways in which the immeasurable difference gets reduced and leveled off.

We are finding out that what we thought physics was might have a lot more to do with *phusis* as the yawning gap of Hesiod than

what we have been led to believe from our historic narratives of science. Likewise, if there is radical exteriority between myself and the other, we will never find resolve in the history of logic, Being and Concept, common sense, etc. which has led us towards binary dualities. We can continue to tell ourselves the historic fables which amount to nothing other than timeless echoes of ourselves or we can recognize our debt to the other which is 'not me' nor the 'not' of the 'not me' but an excess which can never *be* recoverable by me. To doggedly hold on to echoing retreat as ego is to find oneself analogically in the 'wave function-like' state of *il y a* or analogously to whatever horrific awareness corresponds to in the chaos of the quantum wave function. The horrific state of sheer awareness chaotically - without Being, Concept, history, self, temporality/ spatiality, etc. and even without the solace of nothingness. Ipseity, the bare self, then would be the 'luxury' of retreat, of sleep for insomnia. Ipseity as a retreat from il y a fashions ego from the order of existence as being, thinking, functioning. I would remind you of the National Institute of Health studies I cited earlier which understand mental health as ranging from psychotic disorders to healthy behavior having to do with how well the sense of self is developed. To repeat, these extremes range from,

1. "Minimal" self, also referred to as "basic" or "core" self or as "**ipseity**." This is a pre reflective, tacit level of selfhood. It refers to the implicit first-person quality of consciousness, ie, the implicit awareness that all experience articulates itself in first person perspective as "my" experience. In other words, all conscious acts are intrinsically self-conscious, a feature sometimes designated as "self-affection." "Minimal" or "core" self constitutes the foundational level of selfhood on which other levels of selfhood are built.

2. "Narrative" or social self. This refers to characteristics such as social identity, personality, habits, style, personal history, etc. Psychological concepts such as "self-esteem" or

> "self-image" refer to this level of selfhood. This level is widely understood to presuppose the sense of existing as a subject of experience ("minimal self") and often involves reflective, metacognitive processes, in which one's self is largely an object of awareness. 280

The ramifications of this are quite startling if you think about it. The more a society/history caters to the transactional self, the echo of self, the self, which is more isolated within itself, the unhealthier all its selves become. The more a society/history caters to the social self, a sense of the otherness of others, the healthier all its selves become. It seems to me that in the United States we have become more and more insulated within ourselves. Technology seems to have greatly accelerated this tendency in some ways. If this is the case, we are breeding a whole society of unhealthy folks which leads us towards sociological psychosis. This kind of disorder or traditional ways of thinking of chaos as the 'not' if order moves in the direction of the lack of social cohesion as the war of all against all. The more the self is trapped in the mode of transnationalism, the more the place of the other gets replaced with the narcissistic self. Narcissism moves in the direction of psychosis and ipseity, the bare isolated self. A society which breeds such environments will bring forth more extremists, zealots, fanatics, terrorists, etc. in which cohesion of socially accepted facts become fantasies of one's own choosing. Levinas seems to me to tell us that there is more to this than an unhealthy sociological function. This moves an individual towards the bare self which arises in its retreat from exteriority as the 'there is' of il y a.

This reinforces what Levinas is telling us, albeit in the most extreme terms, about il y a and ipseity. So, contrary to popular rhetoric, the more sociality reinforces sameness, the more it reenforces the isolated self of ipseity. This counters diversity and acceptance of difference which is the basis of sociality. Furthermore, Levinas tells us that the difference between me, the

self, is not bridgeable. This does not mean that we are all living in different 'realities'. Levinas goes even further than beyond differences in 'realities'. He calls this difference 'proximity' and means something very specific by this. Levinas tells us that there is a difference in proximity. But that difference in proximity is not difference itself but the impossibility of being indifferent to the other. For Levinas proximity is the inability to be indifferent to the other. The converse of that would also be true in that if we are indifferent to the other there is no proximity which Levinas refers to as ego. One historic narrative of lived spatiotemporality is the mechanistic modernist contention that we exist in linear extension of space and 'now' moments of time. This assumption is not proximity at all but yet one more abstraction in which narcissism thrives, the inability to recognize anything other than oneself as a mechanism in a machine of other mechanisms. However, if there is proximity to the other there is non-indifference which is due to responsibility to the other. This non-indifference he calls *"the-one-for-the-other"*.

> This difference in proximity between the one and the other, between me and a neighbor, turns into non-indifference, precisely into my responsibility. Non-indifference, humanity, the-one-for-the-other is the very signifyingness of signification, the intelligibility of the intelligible, and thus reason. The non-indifference of responsibility to the point of substitution for the neighbor is the source of all compassion. It is responsibility for the very outrage that the other, who qua other excludes me, inflicts on me, for the persecution with which, before any intention, he persecutes me. Proximity thus signifies a reason before the thematization of signification by a thinking subject, before the assembling of terms in a present, a pre-original reason that does not proceed from any initiative of the subject, an anarchic reason. It is a reason before the beginning, before any

> present, for my responsibility for the other commands me before any decision, any deliberation. Proximity is communication, agreement, understanding, or peace. Peace is incumbent on me in proximity, the neighbor cannot relieve me of it. 281

In linguistics and structuralism Saussure tells us that language is nothing more than a system of signs. The signs are signifiers and signified. Perhaps we could also think of this as syntax and semantics. People think of the signified as a kind of coherent meaning which we all simply understand. But that is not what Saussure thinks. He thinks the signified is really a whole new set of signifiers. So, for Saussure there is no metaphysical kind of meaning to the signified that we all just assume we privately know what it is. What we really have is a learned pattern of signifiers in language which only and ever point to other signifiers.

For Levinas, signifiers and signified are a result of the said *visa vie* the third other which I will get into later. For now, the said accounts for the entire historical fascinations and narrations of essence and Being. Levinas writes that the veracity, the truth or facts, of the subject. The subject as given by historical narrative is a representation of itself to itself. It is an assemblage of elements of thought into a structure. In historic narrative the subject is an arrangement of structures. The subject is a signifier in a signified in which the signified is another assemblage or arrangement. All of this is strained through the unity of a presence which is read for re-presencing throughout all the narratives of history. And what shall we make of the signifyingness of the signifier and the signified? In this case signifyingness would then be intelligibility. This would be the essence of Being, the *ipsum esse*.

> As Ipsum Esse Subsistens, God is Ipsum Esse (i.e., Existence or Act of Existence Itself, subsistent of Itself or subsisting by Itself) (Aquinas, Summa Theologiae, I, q. 4, a. 2). As such,

> Ipsum Esse Subsistens contains within Itself or Himself the whole perfection of esse. 282

This assemblage of subjectivity is what Levinas calls the said and "*The veracity of the subject would have no other signification than this effacing before presence, this representation.*" (Levinas, Otherwise Than Being or Beyond Essence, 1981, p. 246). Then Levinas asks what is to be made of communication or the subject as a speaking that is absorbed into the said? In writing of this in "Otherwise Than Being or Beyond Essence", a section entitled, "c: The Subject as a Speaking that is Absorbed in the Said" he writes,

> Nor would it [the subject] have another signification if one attends to the communication of essence manifested to the other, if one takes the saying as a pure communication of a said. The manifestation to the other and the interhuman, intersubjective understanding concerning the being that manifests itself can in turn play its part in this manifestation and this being. The veracity of the subject would be the virtue of a saying in which the emission of signs, insignificant in their own figures, would be subordinate to the signified, the said, which in turn would be conformed to the being that shows itself. The subject would not be the source of any signification independently of the truth of the essence which it serves. A lie would be only the price that being's finitude costs it. A science would be able to totalize being at all levels of its esse by fixing the ontological structures that articulate being. Subjectivity, the ego and the others would be the signifiers and signified in which the subjective representation of being is realized. 283

Levinas refers to these narratives of the said as thematizations. In historical narratives and even common sense thinking itself is based on the said. We believe that knowledge in the widest

meanings of the word comes first and then anything else. Levinas turns this totally around. Levinas tells us that radical alterity (as I think at least a good case has been made by quantum physics) comes first in the saying and then all our confidences and narratives come later in the said. In this case the whole structuralist and postmodern concerns of signifier and signified may well be true. But before that there is the question of signifyingness itself. Parts fitting together might be contrived to try to explain what makes the glue of signifier and signified hold together but the question of signifyingness cannot easily fit into yet another assemblage. This is a kind of kicking the can down the road and hoping no one notices.

Levinas tells us that the "*signifyingness of signification*" and what makes intelligibility, reason, logic, *logos*, is not some metaphysical meaning or historic narrative as a network of signifiers we think of as signified but our non-indifference in proximity to the other. Non-indifference in proximity to the other is substitution of *"the-one-for-the-other"*. Signifyingness is not networks of additional signifiers but substitution as *"the-one-for-the-other"*. Here 'the one' is me of not only responsibility to the other but substitution as expiation of the other. The topic of expiation is another difficult topic in Levinas. I will also return to it later with a simpler explanation in the last section entitled "Ethics and Love". I find it interesting the Levinas, a devout Jew, would use the term expiation. Most commonly, the term is used in Christianity as what Jesus accomplished by dying on the cross. As the dogma goes, Jesus took on the sins of the world, like a sacrificial lamb. Jesus atoned for us by becoming sin for us and thereby relieving us of the punishment of sin. Certainly, some may draw allusions to this in Levinas' use of the term expiation but there is much more to this than that.

Expiation

From our fading modernist notions, we naturally think that my conscience arises within me. But let's bring to mind what the

National Institute of Health studies show and also what just makes sense. When someone isolates themselves and everything is about ‘me’ to the point of extreme self-consciousness, this is called the pre-reflective self. In other words, they have diminished capacity to reflect on themselves. Another way to think this is that their conscience does not bother too much and in the worst case not at all. They speak in the first person a lot and it's always about their experiences. This is the minimal self of ipseity. It is also the basis for transactionalism. Everything by hook or by crook is to benefit them. There is a part of all of us which has that capacity. Most of us are aware that if you sear your conscience long enough it will simply vanish. We call this narcissism. Levinas refers to this as ipseity. It is the minimal bare ego which is an essential part of all of us. While all of us can have that mental health pathology most of us have a better developed sense of ego.

According to Levinas and mental health studies layered on this is a more developed ego which I think of as the ego Freud tells us about. This notion of ego is sandwiched between id (or ipseity) and superego (or perhaps not ego at all but might we think the radical alterity of the other for Levinas). In this case, the ego has fashioned itself in varying degrees between narcissistic transactionalism and a sense of sociability and conscience. This is the ego many of us inhabit throughout our lives. In this higher ego we have a conscience. But at this level narratives of history work through common sense. This is where notions of essence and Being, cause and effect, absolutes, reductionisms, binary dualities all get sifted down into simple common sense. This is also where dominate histories like modernism set the stage for what we think of as reality. In addition to all these influences many wonderful simple folks already have found a way towards a more intuitive and developed sense of self. The more developed self has a feeling, an intuition, about the externality of the other. The self is where we feel other folks’ pain. This is called empathy. This is truly a generous person not because they feel like they have to be but

because they have a highly developed sense of sociality. This is at the top of the National Institute of Health spectrum of a fully developed self.

Now, let's get back to conscience. If someone has a conscience they are not on the bare self, pathological end of the spectrum. They are on the other end of sociability. They are reflective and conscientious about themselves. They have a well-developed sense of others and feel other pain and suffering in a fashion that can be named expiation. The point is that conscience does not arise in ourselves. It comes from without, from the other. Now we can start to see why Levinas' idea of the saying, proximity, diachrony, the radical alterity of the other culminates in Ethics. As a philosopher Levinas is telling us that the other cannot be subsumed by 'me'. When the other is an object of my ambitions, domain, control, power, or even assumed as the same as 'me' there is a reduction which makes itself amenable to, susceptible to, useful to, assumed to be known and understood by, and sets the stage for the less developed end of the mental health spectrum where ipseity and transactionalism reign pathologically supreme.

We have seen from the previous discussion on quantum physics that we have not understood it if it does not blow our socks off or as Bohr puts it, they have "not understood it". The yawning gap of the quantum wave function will never be bridged by the observer effect of 'me' as if we were masters of the quantum universe. All these shenanigans come from branching into reality, historic narratives condensed down into common sense from the lived 'observer effect'. The externality of the quantum wave function cannot have no god or 'me', no absolute, no essence, or being. Neither is it 'beyond' all that. It is an excess which we cannot wrap our brains around, but we can be aware that externality has no common ground to us but also in some spooky way we spring from this excess. But not as origin, as somehow an instant in which we poof-ed. The point is that accusation turning into persecution is not from within. This is from saying where we face the radical

externality of the other. Facing this other as externality arises as ‘me’ from il y a to ipseity to socio-historic ego to self. Facing the he or she (whatever pronoun of lack of pronoun) is the root of the root and the bud of the bud and the sky of the sky of a tree called life [284] – my life.

Levinas is telling us that expiation is the opposite of the echo of narcissism in the assemblage and arrangements of systems of essence and Being. Levinas asks - but what about the ‘me’ which is not an ego which cannot be generalized, the me that I am?

> Here the unicity of the ego first acquires a meaning — where it is no longer a question of the ego, but of me. The subject which is not an ego, but which I am, cannot be generalized, is not a subject in general; we have moved from the ego to me who am me and no one else. Here the identity of the subject comes from the impossibility of escaping responsibility, from the taking charge of the other. Signification, saying — my expressivity, my own signifyingness qua sign, my own verbality qua verb — cannot be understood as a modality of being; the disinterestedness suspends essence. As a substitution of one for another, as me, a man, I am not a transubstantiation, a changing from one substance into another, I do not shut myself up in another identity, I do not rest in a new avatar. As signification, proximity, saying, separation, I do not fuse with anything. Have we to give a name to this relationship of signification grasped as subjectivity? Must we pronounce the word expiation, and conceive the subjectivity of the subject, the otherwise than being, as an expiation? [285]

> Man is not to be conceived in function of being and not-being, taken as ultimate references. Humanity, subjectivity — the excluded middle, excluded from everywhere, null-site — signify the breakup of this alternative, the one-in-the-

> place-of-another, substitution, signification in its signifyingness *qua* sign, prior to essence, before identity. Signification, prior to being, breaks up the assembling, the recollection or the present of essence. On the hither side of or beyond essence, signification is the breathlessness of the spirit expiring without inspiring, disinterestedness and gratuity or gratitude; the breakup of essence is ethics. 286

Signification as saying cannot come into presence in the fashion of Being or essence. Proximity is not mediated by spacetime. Analogously, it might be thought more like all classicism's historic narratives explained in multitudes of the said as collapse or branching play no role in observer effect from the quantum wave function. But this is not mere physics as things that go bump in the night. This is spooky physics which is no longer spooky but radical alterity which faces us, faces me, as he or she. Proximity is *signifyingness* without classical mediation. Proximity as *signifyingness* evokes my responsibility to the other. Here "*the subject comes from the impossibility of escaping responsibility*". This is the one for the other or substitution. Substitution is "*not a transubstantiation, a changing from one substance into another, I do not shut myself up in another identity, I do not rest in a new avatar. As signification, proximity, saying, separation, I do not fuse with anything*". Neither is this God or Jesus or yet another religious account. This is what Levinas calls expiation which involves me intimately. Levinas writes, "*The uniqueness of the self is the very fact of bearing the fault of another.*" 287 This is not ego as ipseity, the pre reflective, tacit level of selfhood implicit in the first-person quality of consciousness, the implicit awareness that all experience articulates itself in first person perspective as "my" experience, the conscious which acts always intrinsically self-conscious, self-affection or auto-affection. This is self as socially one for the other not from the core self as totally caught up within itself but facing an alterity which makes all such notions of me, ego, self, etc. indebted before any such thing as

'my freedom', 'my consciousness', 'my presence'. This is the subject which does not return back to itself to establish itself but incurs an unpayable debt. It is not even consciousness which assembles itself, but which draws itself from indebtedness to radical alterity which it cannot own, negotiate with, even finding its origin in. This is pure signifyingness which has not yet found signifier and signified.

In this sense self arises as responsibility thrown back on itself in *signifyingness* from saying, the interruption or lapse of radical exteriority. So, self does not even arise from imagined decisions in the freedom of ego or the assumptions of substance, Being, or essence. Self arises from responsibility to the other which cannot be denied. We have mildly referred to this as sociality. Levinas writes, *"Obsessed with responsibilities which did not arise in decisions taken by a subject "contemplating freely," consequently accused in its innocence, subjectivity in itself is being thrown back on oneself. This means concretely: accused of what the others do or suffer, or responsible for what they do or suffer."* [288] To turn away from the suffering of the other is to turn towards fictions of ego, echo, Narcissus. The self always stands accused in a passivity beyond all passivity because all the whys, wherefores, cogitations of whodunit cannot come into the said. This passivity of the self is taken as persecution. In transactionalism the ego squelches self, sociability. But persecution leads to action as expiation, the basis of "the-one-for-the-other".

> This accusation can be reduced to the passivity of the self only as a persecution, but a persecution that turns into an expiation. Without persecution the ego raises its head and covers over the self. [289]

The self without accusation and responsibility is the ego of Narcissus who can only hear his own echo. Remember Echo was the nymph who loved Narcissus. "*As Narcissus lay dying Echo mourned him and echoed his words.*" All Echo could do was echo Narcissus' words. The ego without accusation, without expiation, without

"the-one-for-the-other" covers over the self. To be self is to be responsible for the other showing itself in expiation of the other.

> Peace then is under my responsibility. I am a hostage, for I am alone to wage it, running a fine risk, dangerously. This danger will appear to knowing as an uncertainty, but it is transcendence itself, before certainty and uncertainty, which arise only in knowledge. To require that a communication be sure of being heard is to confuse communication and knowledge, to efface the difference, to fail to recognize the signifyingness of the-one-for-the-other in me. I am extracted from the concept of the ego, and am not measured by being and death, that is, escape the totality and structures. I am reduced to myself in responsibility, outside of the fundamental historicity Merleau-Ponty speaks of. Reason is the one-for-the-other! One is immediately inclined to call such a signification lived, as though the bipolarity of the lived and the thematized, to which Husserl's phenomenology has habituated us, did not already express a certain way of interpreting all meaning in function of being and consciousness. As though the responsibility of the-one-for-the-other could express only the naivety of lived experience that is unreflected but promised to thematization. As though the-one-for-the-other of responsibility, the signification of fraternity, could not "float above the waters" of ontology in its irreducible diachrony. As though the interval or the difference that separates the one from the other, which the non-indifference of the-one-for-the-other did not annul, could only be gathered up in a theme or be compressed into a state of soul. To intelligibility as an impersonal logos is opposed intelligibility as proximity. But does the reason characteristic of justice, the State, thematization, synchronization, re-presentation, the logos and being succeed in absorbing into its coherence the intelligibility of proximity in which it

> unfolds? Does not the latter have to be subordinated to the former, since the very discussion which we are pursuing at this moment counts by its said, since in thematizing we are synchronizing the terms, forming a system among them, using the verb to be, placing in being all signification that allegedly signifies beyond being? Or must we reinvoke alternation [the repeated occurrence of two things in turn: "the regular alternation of stressed and unstressed syllables"] and diachrony as the time of philosophy?
>
> If the preoriginal reason of difference, non-indifference, responsibility, a fine risk, conserves its signification, the couple skepticism and refutation of skepticism has to make its appearance alongside of the reason in representation, knowing, and deduction, served by logic and synchronizing the successive. 290

Levinas wants to reverse the commonly understood order where impersonal *logos* give rise to personal, to self. Levinas tells us that *logos* itself arises from the self's responsibility to the other as expiation. Perhaps a quirk but as I discussed much earlier for Heraclitus *logos* would mean more like saying than logic as we understand today. Anyway, without this reversal Levinas writes *logos* would be and has been the object of skepticism (e.g., Nietzsche). Even Positivists distrusted logic in favor of empirical and stochastic observation. *Logos* would arise as the negative, as the power embedded in negation, the 'not', most clearly exhibited by Hegel. Levinas tells us thematization is synchronizing the terms in a system, the System, starting with verbs of being and existence and moving beyond Being to pure, absolute signification itself (e.g., state of soul, Concept, etc.). The coupling of "*skepticism and refutation of skepticism has to make its appearance alongside of the reason in representation, knowing, and deduction, served by logic and synchronizing the successive*" meaning effectively, rationality must float above and beyond indebtedness to the other. But if saying is

preoriginal, prior to reason, a nonnegotiable, non-indifference of the one for the other, proximity to the other as pure *signifyingness* which cannot found itself then even reason and logic itself must answer to responsibility and Ethics.

Levinas tells us that the chasm between myself and other cannot come into my 'reality' or any narrative of 'reality'. My 'reality' left to itself, to the ego of historic narrative, does not include the other as radical alterity. The 'my' which takes 'reality' to itself excludes the other to the point of retreat which must always be the negative of what it cannot endure. The other is not the other if that absolutely means my idea of the other. The radical alterity of the other cannot have anything to do with my 'reality'. My analogous way of thinking about this is as the hypothetical awareness in the quantum wave function which has no branching into classicism as the observer effect. The wave function could be said to be passivity more passive than all passivity. Might this be an untraceable lapse which the observer effect branching cannot give an account for? The observer effect from the other can be thought of as a kind of spooky branch into the 'me here now' which cannot find its source in a return to itself in the 'me here now'. In the passivity of the wave function a void, a yawning gap, which knows nothing of origin "*undoes thematization, and escapes any principle, origin, will, or* ἀρχή*, which are put forth in every ray of consciousness. This movement is, in the original sense of the term, an-archical.*" (Levinas, Otherwise Than Being or Beyond Essence, 1981, p. 197)

Therefore, I am indebted to the other not because I have an altruistic ethic of the other, but because the other in an observer-like saying awakens me as existent. But I cannot find or recover an origin in the call of the other from the externality of the other. The calling of the other as Levinas' saying cannot found, originate, cause and effect, rule and authority, etc. There is no metaphysic which binds me to the other as in the Christian mythos which makes us all children of the parent God with a hereditary and eternal connection which we will find when we die and go to heaven as long as we do

x, y, and z. This is reciprocity and transactionalism of the *meta*. The externality of the other in the retreat of ego covers over self and its non-indifference of one for the other as signifyingness. Responsibility to the other is not because they exist like me, and I 'should' be nice to them (as long as they buy what I am selling). There is not a case of "you do this, and I will do that" as transactionalism. This goes much further. Expiation is constituent of selfhood.

If Levinas is correct and I think he is, the self which is not hanging on the horrific brink of ipseity and il y a, the psychotic state of affairs, but *is* a debt which I cannot repay. Even more,

> The more I answer the more I am responsible; the more I approach the neighbor with which I am encharged the further away I am. This debit which increases is infinity as an infinition of the infinite, as glory. 291

I am not merely called by the other into self. The very selfness of self arises from the undeniable call of the other. Healthy sociality is not simply an option, it is a necessity for me to even range from ipseity to self. Even further, Levinas tells us that responsibility not only rests on debt to the other but on expiation. Expiation is what even Levinas refers to as the "nonsensical idea" that I am responsible for the other even as far as taking on their burden, their shame as if it were mine.

Essence on the verge of abysmal meaninglessness can no longer arouse itself in an attempt to once more complete itself. Essence at our abyss "*stretching on indefinitely, without any possible halt or interruption, the equality of essence not justifying, in all equity, any instant's halt, without respite, without any possible suspension, is the horrifying* ***there is***". (Levinas, Otherwise Than Being or Beyond Essence, 1981, p. 289) In essence's frenetic gasp to delete itself, it more and more insists on itself. Violence as the only recourse unconsciously wants annihilation, believing that the metaphysics of

nothing yet has a promise for the dying or for Nietzsche's heroic affirmation of eternally recurrent tragedy. But Levinas tells us that even nothing cannot die. Instead, *there is*. In naming il y a, could it be that we also might think of awareness which cannot branch from the quantum wave function? Awareness which cannot cover itself with the fig leaves of Being and essence? Awareness which can only persist as the wave function persists not as nothing but as awareness of no-thing, as insomniacs' awareness. Might we think unassembled exformation without spacetime or cause and effect, chaos which cannot gather itself from absolute indeterminateness which would not afford an observer effect fleeing refuge from the no exit of sheer awareness, no retreat from pure immediacy? Levinas writes,

> Essence stretching on indefinitely, without any possible halt or interruption, the equality of essence not justifying, in all equity, any instant's halt, without respite, without any possible suspension, is the horrifying there is behind all finality proper to the thematizing ego, which cannot sink into the essence it thematizes. 292

Essence absolutely depleted finds no *logos*, no word or theme. Narcissus' echo eternally obliviated where only the worm of bare awareness cannot live or die, cannot fall from the wave function in the observer effect, cannot live or die, cannot sleep or wake, and neither can it even echo itself as self-conscious or awareness of awareness but must only stare interminably without even underworld or echo of itself back to itself. This is the vacuum of one without another. Perhaps we again think analogically of branching from the wave function as *il y a*. Pure signification not yet called (observed) from radical externality, not yet the saying of the other, the observer. The other's grace calling-saying-observing-falling from unimaginable, horrific *il y a* having no retreat. I will get into this more a little further down, but I see it as a kind of volitional grace

for ego to even have the possibility of retreat from ipseity facing *il y a* and to even be able to abandon its freedom as essence, as its own echo and return to the persecuted self, "*the-one-for-the-other*" which is unable to be able. As we will see, ego is a retreat which cannot escape from radical exteriority and the indebtedness of selfhood. But ego is a kind of emotive, historically based escape route from the self of responsibility for the other. Ego is a volitional devolution from the self, the-one-for-the-other, an egoistic echo from the persecuted self (to be discussed further down), to dramatize itself transactionally.

> It is inasmuch as the signification of the-one-for-the-other is thematized and assembled, and through the simultaneity of essence, that the one is posited as an ego, that is, as a present or as a beginning or as free, as a subject facing an object. But it is also posited as belonging to essence, which when assembled cannot leave anything outside, has no outside, cannot be worn away. This way for the subject to find itself again in essence, whereas essence, as assembled, should have made possible the present and freedom, is not a harmonious and inoffensive participation. 293

Yet, at the end of the epoch of Being, essence has worn itself down to "*incessant buzzing*" which finds it harder and harder to ignore the meaninglessness of repetition. Sociologically, ego wears thin with only a bare rumbling, its ceaseless buzz, which is losing it egoist imaginings increasingly once again towards *there is*.

> It is the incessant buzzing that fills each silence, where the subject detaches itself from essence and posits itself as a subject in face of its objectivity. A rumbling intolerable to a subject that faces itself as a subject, and assembles essence before itself as an object. But its own subtraction is unjustifiable in an equal woven fabric, of absolute equity.

> The rumbling of the there is is the non-sense in which essence turns, and in which thus turns the justice issued out of signification. There is ambiguity of sense and non-sense in being, sense turning into non-sense. It cannot be taken lightly. 294

How much longer must egoist repetition exhaust itself?

With that right does the idealist extract the ego from being and confer upon it a transcendental status, when the subject returns to being in the very stability of its status? (Levinas, Otherwise Than Being or Beyond Essence, 1981)

But Levinas tells us that all the while imagined freedom as choice awaits the dying echo of *there is,* the egoity of Hamlet which cries, “To die, to sleep – to sleep, perchance to dream – ay, there's the rub, for in this sleep of death what dreams may come…” But what if the ‘dream’ is nightmare beyond all imaginings, one without any other? The inability to be able to die to dreams as perhaps we could analogously imagine as the unescapable experience of stark and bare awareness, of chaotic unassembled exformation in which the possibility of retreat is impossible, one without another, where even ‘oneself’ has hollowed itself out. But essence only plays well in the vacuousness of ego. Levinas calls signification the *evacuation of Being’s essence for the other*.

> But the forgetting of ambiguity would be as little philosophical. It is in its ex-ception and ex-pulsion as a responsible one that a subject outside of being can be conceived. In signification, in the-one-for-the-other, the self is not a being provisionally transcendental and awaiting a place in the being it constitutes. Nor is it the absolute being of which phenomena would express only the coherent dream. The one in the-one-for-the-other is not a being outside of being, but signification, evacuation of Being’s essence for the other. 295

The vacuous repetition of il y a can only dream as Narcissus' stark and bare awareness which cannot branch from itself, from the saying (observation) of the other, nor even yet *be* the ego of essence and its own echoing freedom. The saying of the other (the observer) speaks ego and ipseity from dark simultaneity admitting no temporality, from annihilation as chaotic unassembled exformation in which no possibility for retreat is possible. What remains after all *evacuation of Being's essence*, and every freedom of the ego has been exhausted? Perhaps the self as *substitution for the other*. Could it be that the absurdity of the *there is* may constitute a signification, a signification not yet signifier or signified of *the-one-for-the-other*? Could it be that beneath essence there is a surplus over classically esteemed sensibility the lowly, the insignificant, nonsense, and absurdity?

> The self is a substitution for the other, subjectivity as a subjection to everything, as a supporting everything and supporting the whole. The incessant murmur of the there is strikes with absurdity the active transcendental ego, beginning and present. But the absurdity of the there is, as a modality of the-one-for-the-other, signifies. The insignificance of its objective insistence, recommencing behind every negation, overwhelms me like the fate of a subjection to all the other to which I am subject, is the surplus of nonsense over sense, through which for the self expiation is possible, an expiation which the oneself indeed signifies. **The there is is all the weight that alterity weighs supported by a subjectivity that does not found it.** But one must not say that the there is results from a "subjective impression." In this overflowing of sense by nonsense, the sensibility, the self, is first brought out, in its bottomless passivity, as pure sensible point, a dis-interestedness, or subversion of essence. 296

Levinas tells us "*Behind the anonymous rustling of the there is*" is a "*passivity more passive than all passivity*" and otherwise than being, signification meaning the-one-for-the-other makes possible the subjectivity of the self as substitution, expiation.

> Behind the anonymous rustling of the there is subjectivity reaches passivity without any assumption. Assumption would already put in a correlation with an act this passivity of the otherwise than being, this substitution prior to the opposition of the active and the passive, the subjective and the objective, being and becoming. In the subjectivity of the self, substitution is the ultimate retraction of passivity, the opposite of the assumption in which the receptivity which the finitude of a transcendental I think describes is completed, or which it presupposes. The identity of the chosen one, that is, the assigned one, which signifies before being, would get a foothold and be affirmed in essence, which negativity itself determines. To support without compensation, the excessive or disheartening hubbub and encumberment of the there is is needed. 297

Expiation as substitution of the one-for-the-other is the who resulting from "*persecuted subjectivity*". "*Persecuted subjectivity*" as a "*passivity more passive than all passivity*" has no origin (i.e., essence, Being, etc.). Levinas calls this the anarchy of passivity. Let's try to get some perspective on the self and the ego. The self facing the externality of the other, the radical alterity of the other has no way to understand, put into context, make sense of the lapse of radical externality. This reflects a "*passivity more passive than all passivity*" in the self's inability to be able. Il y a is really an orientation of signifyingness, of this absolute 'inability to be able'. The inability to be able results in a retreat into historic answers and commonsense assumptions. The reason il y a is so horrific is because of the inability of self to be able as the-one-for-the-other. This is

persecution of the self. Due to persecution, the self in egoity wants to withdraw to the bare self of ipseity. The bare self, already obligated but unable to be able to meet its obligation, is persecuted in the face of the lapse of radical externality, of the other it cannot understand, or come to grips with. Therefore, the self's retreat is its bare self, is il y a, the horror it cannot bear. Historic narratives have been fashioned as distraction, as allusion, as essence, Being, God. etc. The ego then arises from ipseity, the bare self facing the horror of *il y a*.

The retreat from the inability to be able is the ego which imagines itself to be free and, as Narcissus, rooted absolutely in itself as essence, Being, 'reality', etc. This is the synchronic play of language and philosophy in the sensible arena of signifier and signified. This is where identity is formed. This arises from the lapse of the saying into the echo of the said. The said recuperates and collapses into consciousness as time. It is a change imposed upon duration. The unitary operator in the quantum wave function has no temporality except from semiclassical branching as an independent variable. Synchronic temporality is already classicism, already the said of history and narration. Radical exteriority "*does not exhaust the signifyingness of the sensible and of immediacy, is its play, logical and ontological, as consciousness*". From radical externality, from diachronic other as saying, as observer, signifyingness not yet sensible, classical, clothed with signifiers and signified. In the wave function we find all possibilities not yet observed into actuality. For Levinas the saying of the other arrives diachronously, anarchically as if branching (the observer effect) as 'me', as conscious. Signifyingness is saying collapsing into said is as *logos*.

> In the sensible as lived, identity shows itself, becomes a phenomenon, for in the sensible as lived is heard and "resounds" essence, the lapse of time and the memory that recuperates it, consciousness; the time of consciousness is the

resonance and understanding of time. But this ambiguity and this gnoseological function of sensibility, this ambiguity of the understanding and intuition that does not exhaust the signifyingness of the sensible and of immediacy, is its play, logical and ontological, as consciousness. This play does not begin by caprice; we will have to show the horizon in which it occurs. But this play does not undo the responsibilities that arouse it. In analyzing the sensible in the ambiguity of duration and identity, which is already the ambiguity of the verb and the noun that scintillates in the said, we have found it already said. Language has been in operation, and the saying that bore this said, but goes further, was absorbed and died in the said, was inscribed. Or, if one likes, our analysis concerned the time that marks historiography, that is, the recuperable time, the recoverable time, the lost time that can be found again. As the time narrated becomes, in the narrative and in writing, a reversible time, every phenomenon is said, characterized by the simultaneity of the successive in a theme. In the remission or detente of time, the same modified retains itself on the verge of losing itself, is inscribed in memory and is identified, is said. The lived, a "state of consciousness," a being, designated by a substantive, is distended, in the time of lived experience, into life, into essence, into a verb but across the opening that the diastasis of identity works, across time, the same finds again the same modified. Such is consciousness. These rediscoveries are an identification — of this as this or as that. Identification is ascription of meaning. Entities show themselves in their meanings to be identical entities. They are not first given and thematized, and then receive a meaning; they are given by the meaning they have. But these rediscoveries by identification occur in an already said. 298

Signifyingness makes meaning possible as essence and existence.

Consciousness or awareness rises from signifyingness. But signifyingness bears the trace of il y a, the impersonal rustling of the sheer terror of awareness with signifier and signified, being, essence, temporality, devoid of any object but unable to find self-consciousness. The other speaking or observing commands me as unpayable debt, responsibility which cannot remain il y a. Responsibility is Ethics. Responsibility stifles the primordial horror of il y a temporalizes me into the said. The ethical relation emerges from signifyingness, the anonymity of il y a, giving rise to self-consciousness made ready for the said and the burden of justice in the third other to be discussed next.

So, the extremity of the retreat of ipseity facing il y a as signifyingness makes the signifier or signified possible as the said. The said stands for something very different from the horror that ipseity in the throes of il y a portrays. The said is a placeholder, the echo, for the self arising from signifyingness, unable to be able. The self is already beholden in facing the radical alterity of the other. This is what Levinas refers to as persecution. In the quote below Levinas is addressing the obvious question of whether or not we have duped ourselves and simply reiterated the history of essence in perhaps a more subtle fashion.

> In this exposition of the in itself of the persecuted subjectivity, have we been faithful enough to the anarchy of passivity? In speaking of the recurrence of the ego to the self, have we been sufficiently free from the postulates of ontological thought, where the eternal presence to oneself subtends even its absences in the form of a quest, where eternal being, whose possibles are also powers, always takes up what it undergoes, and whatever be its submission, always arises anew as the principle of what happens to it? It is perhaps here, in this reference to a depth of anarchical passivity, that the thought that names creation differs from ontological thought. It is not here a question of justifying the

theological context of ontological thought, for the word creation designates a signification older than the context woven about this name. In this context, this said, is already effaced the absolute diachrony of creation, refractory to assembling into a present and a representation. But in creation, what is called to being answers to a call that could not have reached it since, brought out of nothingness, it obeyed before hearing the order. Thus in the concept of creation ex nihilo, if it is not a pure nonsense, there is the concept of a passivity that does not revert into an assumption. The self as a creature is conceived in a passivity more passive still than the passivity of matter, that is, prior to the virtual coinciding of a term with itself. The oneself has to be conceived outside of all substantial coinciding of self with self. Contrary to Western thought which unites subjectivity and substantiality, here coinciding is not the norm that already commands all non-coinciding, in the quest it provokes. Then the recurrence to oneself cannot stop at oneself, but goes to the hither side of oneself; in the recurrence to oneself there is a going to the hither side of oneself. A does not, as in identity, return to A, but retreats to the hither side of its point of departure. Is not the signification of responsibility for another, which cannot be assumed by any freedom, stated in this trope? Far from being recognized in the freedom of consciousness, which loses itself and finds itself again, which, as a freedom, relaxes the order of being so as to reintegrate it in a free responsibility, the responsibility for the other, the responsibility in obsession, suggests an absolute passivity of a self that has never been able to diverge from itself, to then enter into its limits, and identify itself by recognizing itself in its past. Its recurrence is the contracting of an ego, going to the hither side of identity, gnawing away at this very identity — identity gnawing away at itself — in a remorse. Responsibility for

another is not an accident that happens to a subject, but precedes essence in it, has not awaited freedom, in which a commitment to another would have been made. I have not done anything and I have always been under accusation — persecuted. The ipseity, in the passivity without arche characteristic of identity, is a hostage. The word I means here I am, answering for everything and for everyone. Responsibility for the others has not been a return to oneself, but an exasperated contracting, which the limits of identity cannot retain. Recurrence becomes identity in breaking up the limits of identity, breaking up the principle of being in me, the intolerable rest in itself characteristic of definition. The self is on the hither side of rest; it is the impossibility to come back from all things and concern oneself only with oneself. It is to hold on to oneself while gnawing away at oneself. Responsibility in obsession is a responsibility of the ego for what the ego has not wished, that is, for the others. This anarchy in the recurrence to oneself is beyond the normal play of action and passion in which the identity of a being is maintained, in which it is. It is on the hither side of the limits of identity. This passivity undergone in proximity by the force of an alterity in me is the passivity of a recurrence to oneself which is not the alienation of an identity betrayed. What can it be but a substitution of me for the others? It is, however not an alienation, because the other in the same is my substitution for the other through responsibility, for which, I am summoned as someone irreplaceable. I exist through the other and for the other, but without this being alienation: I am inspired. This inspiration is the psyche. The psyche can signify this alterity in the same without alienation in the form of incarnation, as being-in-one's-skin, having-the-other-in-one's-skin.

In this substitution, in which identity is inverted, this passivity more passive still than the passivity conjoined with

> action, beyond the inert passivity of the designated, the self is absolved of itself. Is this freedom? It is a different freedom from that of an initiative. Through substitution for others, the oneself escapes relations. At the limit of passivity, the oneself escapes passivity or the inevitable limitation that the terms within relation undergo. In the incomparable relationship of responsibility, the other no longer limits the same, it is supported by what it limits. Here the overdetermination of the ontological categories is visible, which transforms them into ethical terms. In this most passive passivity, the self liberates itself ethically from every other and from itself. Its responsibility for the other, the proximity of the neighbor, does not signify a submission to the non-ego; it means an openness in which being's essence is surpassed in inspiration. It is an openness of which respiration is a modality or a foretaste, or, more exactly, of which it retains the aftertaste. Outside of any mysticism, in this respiration, the possibility of every sacrifice for the other, activity and passivity coincide. 299

In the passage above Levinas asks how can we be sure that we are not yet once again weaving a tale of origin, ontology, and essence? How can we be sure that the saying is not already the said? The said already effaces diachrony as creation. I think what he means is that the said always papers over something which cannot be made commensurate with my time or my space. By 'anarchic creation' "*what is called to being answers to a call that could not have reached it since, brought out of nothingness, it obeyed before hearing the order.*" "*The self as a creature is conceived in a passivity more passive still than the passivity of matter, that is, prior to the virtual coinciding of a term with itself.*" "*A does not, as in identity, return to A, but retreats to the hither side of its point of departure.*" Ok, you might be thinking this sounds really mystic. Let's look for an analogy (if Levinasian philosophers have made it this far, which would be a

miracle, this will surely finish them off from my quantum nonsense). But doesn't the wave function also have a ring of mystic to it relative to classicism? Reread the quotes I just cited in terms of what physicists might be telling us about the quantum wave function.

- "*called into being*" => from the observer effect branching into classicism?
- "*answers to a call that could not have reached it since, brought out of nothingness, it obeyed before hearing the order*" => branching of the wave function perhaps intuitively thought of as 'nothingness' in classicism's terms? The metaphysical notion of nothingness would not be a reciprocity as if the decohered branch could be reversed back into the wave function. But the wave function prior to spacetime in its simultaneity already includes in superposition what we think of as 'my branch' plus all the other branches (e.g., many-worlds or perhaps better overlapping confluences, etc.) In obeying before hearing the order seems a lot like the fall into classicism in which reciprocity is not only irreversible but also cannot even be made commensurate.
- "*The self as a creature is conceived in a passivity more passive still than the passivity of matter, that is, prior to the virtual coinciding of a term with itself*" => the self, conceived as branching from the wave function, the self, *more passive still than the passivity of matter*, the self, as not ontological, not epistemological not essence or classicism, and the self "*prior to the virtual coinciding of a term with itself*". The self, branching from the wave function is not a term of identity which coincides with itself.
- "*A does not, as in identity, return to A, but retreats to the hither side of its point of departure*" => The observer as subject as one possible branch of innumerable branches is

not identical to itself but retreats to the hither side of its point of departure? Could this insinuate that the branched 'self' observed/spoken from the wave function having already included in superposition what we think of as 'my branch' plus all the other branches – could this refer to the '*hither side of its point of departure*" simultaneously "*brought out of no-thingness*"

- "*anarchy of passivity*" = > the chaos of the universal[300] wave function

I suppose if there is anything to this analogy it could be thought of as more of an intuition on the part of Levinas. Again, Levinas arrives at his philosophy from his scholarly knowledge of the history of philosophy without resorting in any way to quantum physics. But since in this book I am looking for ways to communicate Levinas ideas with hopefully *easier* analogies I think this *could* be helpful. Is this a *real* thing? I guess that all hinges on what we mean by 'real' to give a *cliché* philosophical answer.

The Third Other

Levinas does not simply criticize the classical history of *logos*, essence, Being, etc. He thinks it legitimately arises from the encounter of the third other. So far, I have tried to elucidate how Levinas understand the encounter with the other as radical alterity. But we do not just encounter an other. We encounter others. The ego is not a solidary phenomenon. It cannot be taken up completely into a generalized concept, but it faces multiple others, third parties, which necessitates decisions. Here, the third party can also be extended as communities, politics, any and all injustices which responsibility cannot deny.

> To say that the ego is a substitution is then not to state the universality of a principle, the quiddity of an ego, but, quite

> the contrary, it is to restore to the soul its egoity which supports no generalization. The way by which, from this situation, the logos arises to the concept of the ego passes through the third party. The subject as an ego is not an entity provided with egoity as an eidetic structure, which should make it possible to form a concept of it, and make the singular entity be its realization. 301

Responsibility as previously described is not just to an other but others. From facing others, the ego has to concern itself with justice.

> To be sure — but this is another theme — my responsibility for all can and has to manifest itself also in limiting itself. The ego can, in the name of this unlimited responsibility, be called upon to concern itself also with itself. The fact that the other, my neighbor, is also a third party with respect to another, who is also a neighbor, is the birth of thought, consciousness, justice and philosophy. The unlimited initial responsibility, which justifies this concern for justice, for oneself, and for philosophy can be forgotten. In this forgetting consciousness is a pure egoism. 302

Responsibility not only places a demand on me but in the encounter of others self-consciousness is born. The third party places a demand on me to decide justice. Justice itself arises in the impossibility of contradiction in the saying between two radical alterities who face me. Justice is demanded of responsibility. From this inescapable demand *logos* arising as historic narrative in the necessity of justice as the comparable if incomparables. An equality of inequalities must assemble order, thematization, language, knowledge, intelligibility in the court of justice. Even the history of essence and Being arises from impossible justice.

If proximity ordered to me only the other alone, there would have not been any problem, in even the most general sense of the term. A question would not have been born, nor consciousness, nor self-consciousness. The responsibility for the other is an immediacy antecedent to questions, it is proximity. It is troubled and becomes a problem when a third party enters.

The third party is other than the neighbor, but also another neighbor, and also a neighbor of the other, and not simply his fellow. What then are the other and the third party for one another? What have they done to one another? Which passes before the other? The other stands in a relationship with the third party, for whom I cannot entirely answer, even if I alone answer, before any question, for my neighbor. The other and the third party, my neighbors, contemporaries of one another, put distance between me and the other and the third party. “Peace, peace to the neighbor and the one far-off” (Isaiah 57: 19) — we now understand the point of this apparent rhetoric. The third party introduces a contradiction in the saying whose signification before the other until then went in one direction. It is of itself the limit of responsibility and the birth of the question: What do I have to do with justice? A question of consciousness. Justice is necessary, that is, comparison, coexistence, contemporaneousness, assembling, order, thematization, the visibility of faces, and thus intentionality and the intellect, and in intentionality and the intellect, the intelligibility of a system, and thence also a copresence on an equal footing as before a court of justice. Essence as synchrony is togetherness in a place. Proximity takes on a new meaning in the space of contiguity. But pure contiguity is not a “simple nature.” It already presupposes both thematizing thought and a locus and the cutting up of the continuity of space into discrete terms and the whole — out of justice.

> Thus one would understand, in proximity, in the saying without problems, in responsibility, the reason for the intelligibility of systems. The entry of a third party is the very fact of consciousness, assembling into being, and at the same time, in a being, the hour of the suspension of being in possibility, the finitude of essence accessible to the abstraction of concepts, to the memory that assembles in presence, the reduction of a being to the possible and the reckoning of possibles, the comparison of incomparables. It is the thematization of the same on the basis of the relationship with the other, starting with proximity and the immediacy of saying prior to problems, whereas the identification of knowing by itself absorbs every other. 303

The 'said' arises from the imposition of the third party. Even consciousness must be called upon, brought forth, into the present demand. Justice cannot arise from empiricism or even from logic. All of that is after the fact and irrelevant to the demand of justice. Proximity faces multiple diachronies from which justice is required as the origin of appearing, as the very origin of origin itself.

> Consciousness is born as the presence of a third party. It is in the measure that it proceeds from it that it is still disinterestedness. It is the entry of the third party, a permanent entry, into the intimacy of the face to face. The concern for justice, for the thematizing, the kerygmatic discourse bearing on the said, from the bottom of the saying without the said, the saying as contact, is the spirit in society. And it is because the third party does not come empirically to trouble proximity, but the face is both the neighbor and the face of faces, visage and visible, that, between the order of being and of proximity the bond is unexceptionable. Order, appearing, phenomenality, being are produced in signification, in proximity, starting with the

> third party. The apparition of a third party is the very origin of appearing, that is, the very origin of an origin. [304]

The un-resolvability of proximity with the necessity of justice for unreconcilable radical alterities cannot be ignored but must remain ambivalent and an enigma. There will never be a final justice as there are never finalities to radical alterity and proximity. But neither can there be an existential requirement to disregard justice. There is no justice in the death of a loved one, the intolerability of war, the destitution of poverty and neither is there any escape from having to decide and suffering the devastating pain in which decision fails no matter what justice and wisdom demands from us. Illeity is an external embodiment of the self. [305] Justice draws us out of ourselves in order to decide, to be held accountable for responsibility. All of histories externalizing as Being, Concept, God, truth, etc. is the placeholder for what I must do as disinterested from my personal desires, acquisitions, narcissistic echoes of myself. The demand for justice which is not 'my justice' is not abnegate-able. Even in spurning the demand we have bad conscience, painful feeling we get when you say something hurtful, or do something to a friend that we regret, for example or when we feel like we haven't done a good enough job. Bad conscience mostly exists as a social function, a sin against conscience. In the impossibility of this demand, we cannot rest in ourselves as sufficient, as able to be able, and yet having to act externalizing us, not at ease in our insufficiency. Those who do not feel bad conscience have acquiesced to narcissism, illeity as externalizing themselves into shells, vacancies of responsibility. In either case, responding to the demand for justice or neglecting the demand for justice, the impossibility of justice is maintained.

> The way leads from responsibility to problems. A problem is posited by proximity itself, which, as the immediate itself, is without problems. The extraordinary commitment of the

other to the third party calls for control, a search for justice, society and the State, comparison and possession, thought and science, commerce and philosophy, and outside of anarchy, the search for a principle. Philosophy is this measure brought to the infinity of the being-for-the-other of proximity, and is like the wisdom of love. But, come out of signification, a modality of proximity, justice, society and truth itself which they require, must not be taken for an anonymous law of the "human forces" governing an impersonal totality.

It is through its ambivalence which always remains an enigma that infinity or the transcendent does not let itself be assembled. Removing itself from every memorable present, a past that was never present, it leaves a trace of its impossible incarnation and its inordinateness in my proximity with the neighbor, where I state, in the autonomy of the voice of conscience, a responsibility, which could not have begun in me, for freedom, which is not my freedom. The fleeting trace effacing itself and reappearing is like a question mark put before the scintillation of the ambiguity: an infinite responsibility of the one for the other, or the signification of the Infinite in responsibility. There is an ambiguity of the order that orders to me the neighbor who obsesses me, for whom and before whom I answer by my ego, in which being is inverted into a substitution, into the very possibility of gift — and of an infinite illeity, glorious in the human plot hatched in proximity, the subversion of essence into substitution. In it I could not arise soon enough to be there on time, nor approach without the extraordinary distance to be crossed augmenting before every effort to assemble it into an itinerary. Illeity overflows both cognition and the enigma through which the Infinite leaves a trace in cognition. Its distance from a theme, its reclusion, its holiness, is not its way to effect its being (since its past is anachronous and

anarchic, leaving a trace which is not the trace of any presence), but is its glory, quite different from being and knowing. It makes the word God be pronounced, without letting “divinity” be said. That would have been absurd, as though God were an essence (that is, as though he admitted the amphibology of being and entities), as though he were a process, or as though he admitted a plurality in the unity of a genus. Does God, a proper and unique noun not entering into any grammatical category, enter without difficulties into the vocative? It is non-thematizable, and even here is a theme only because in a said everything is conveyed before us, even the ineffable, at the price of a betrayal which philosophy is called upon to reduce. Philosophy is called upon to conceive ambivalence, to conceive it in several times. Even if it is called to thought by justice, it still synchronizes in the said the diachrony of the difference between the one and the other, and remains the servant of the saying that signifies the difference between the one and the other as the one for the other, as non-indifference to the other. Philosophy is the wisdom of love at the service of love. (Levinas, Otherwise Than Being or Beyond Essence, 1981, pp. 287-289)306

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Also, Why More Physicists Are Starting to Think Space and Time Are ‘Illusions’

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Also ARISTOTLES_CONCEPT_OF_GOD

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From Latin theo- ("god"), combining form of theos ("god"); from Ancient Greek θεό- (*theó-*, "god"), combining form of θεός (*theós*, "god").

Also, θεός

From Proto-Hellenic *tʰehós (whence also Mycenaean Greek (*te-o*)), a thematicization of Proto-Indo-European *dʰéh₁s, from *dʰeh₁- ("to do, to put, to place") + *-s. Cognate with Phrygian δεως (*deōs*, "to the gods"), Old Armenian դիք (*dikʿ*, "pagan gods") and Latin fēriae ("festival days"), fānum ("temple") and fēstus ("festive").

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"LEVINAS, ROSENZWEIG, AND THE PHENOMENOLOGIES OF HUSSERL AND HEIDEGGER"

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And thing-in-itself

And noumenon

127 See It from Bit: Pioneering Physicist John Archibald Wheeler on Information, the Nature of Reality, and Why We Live in a Participatory Universe

And Bit from It

And It from bit?

128 See neuter – not either, neither of the two

neuter (adj.) – late 14c., of grammatical gender, "neither masculine nor feminine," from Latin neuter "of the neuter gender," literally "neither one nor the other," from ne- "not, no" (from PIE root *ne- "not") + uter "either (of two)" (see whether). Probably a loan-translation of Greek oudeteros "neither, neuter." In 16c., it had the sense of "taking neither side, neutral."

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See Being at the Beginning: Heidegger's Interpretation of Heraclitus (.pdf)

248 Veneziano, Gabriele. Febuary 1, 2006. "The Myth Of The Beginning Of Time". Scientific American (online)

Brian Greene, *The Fabric of the Cosmos: Space, Time, and the Texture of Reality* (New York: Alfred A. Knopf, 2004), 272.

249 John Gribbin, *In the Beginning: The Birth of the Living Universe* (London: Penguin Books, 1993), 23.

See Creation Chaos Time from Myth to Modern Cosmology (pdf)

250 Jacques Derrida is the primary postmodern philosopher associated with "erasure" or overstriking (sous rature) words like "universal," "truth," or "being." This technique signals that a word is necessary for language yet inadequate or deceptive, challenging the stability of traditional philosophical concepts.

251 See George Orwell and Emmanuel Levinas Introspective: Socialism and the Other | Musings (mixermuse.com)

252 Immanuel Kant, *Critique of Pure Reason*, trans. Paul Guyer and Allen W. Wood (Cambridge: Cambridge University Press, 1998), 248.

253 See Immanuel Kant (IEP)

And Kant on the identity of persons

And Kant's Theory of Self-Consciousness

And Identity of the Self in Kant

254 Emmanuel Levinas, *Otherwise Than Being or Beyond Essence*, trans. Alphonso Lingis (The Hague: Martinus Nijhoff, 1981), 75.

255 Immanuel Kant, *Prolegomena to Any Future Metaphysics*, trans. Paul Carus (Chicago: Open Court, 1902), 148–49.

See Immanuel Kant: Prolegomena to Any Future Metaphysics (.pdf)

256 "Hegel," in *The Philosophy Book: Big Ideas Simply Explained* (New York: DK Publishing, 2011), 178.

See The Trouble with Hegel.

257 Friedrich Wilhelm Joseph von Schelling, *The Grounding of Positive Philosophy: The Berlin Lectures*, trans. Bruce Matthews (Albany: State University of New York Press, 2007), 164.

See The Philosophy of Spirit (Jena Lectures 1805-6): PART I. Spirit according to its Concept

258 Thomas Nenon, *Objectivity and System: A Study of Kant's Theory of Experience* (The Hague: Martinus Nijhoff, 1986), 133.

See Hegel, Reason, and Idealism

259 Emmanuel Levinas, *Otherwise Than Being or Beyond Essence*, trans. Alphonso Lingis (The Hague: Martinus Nijhoff, 1981), 200–201.

260 Angelica Nuzzo, "The 'Absoluteness' of Hegel's Absolute Spirit," in *Hegel's Philosophy of Spirit: A Critical Guide*, ed. Marina F. Bykova (Cambridge: Cambridge University Press, 2019), 189–90.

261 According to Hegel, the relationship between self and otherness is the

fundamental defining characteristic of human awareness and activity, being rooted as it is in the emotion of desire for objects as well as in the estrangement from those objects, which is part of the primordial human experience of the world. The otherness that consciousness experiences as a barrier to its goal is the external reality of the natural and social world, which prevents individual consciousness from becoming free and independent. However, that otherness cannot be abolished or destroyed, without destroying oneself, and so ideally there must be reconciliation between self and other such that consciousness can "universalize" itself through the other.

Hegel: Social and Political Thought

262 Emmanuel Levinas, *Otherwise Than Being or Beyond Essence*, trans. Alphonso Lingis (The Hague: Martinus Nijhoff, 1981), 200.

263 See 5 - Being-towards-death

And Heidegger on "Being-Toward-Death"

And Being and Time part 6: Death

And What is the character of Heidegger's notion of authenticity in being-towards-death?

264 Martin Heidegger, *Being and Time*, trans. John Macquarrie and Edward Robinson (Oxford: Blackwell, 1962), 303, 307, 308–9.

265 See Death, Hegel, and Kojève (.pdf)

And Hegel, Death and Sacrifice

And GEORG WILHELM FRIEDRICH HEGEL from Philosophy of Right

And 4 Hegel's Conception of Tragedy

266 See There Are Only Two Tragedies. One Is Not Getting What One Wants, and the Other Is Getting It

267 See Shakespeare: Three Plays About Human Desire

And Shakespeare: Three Plays About Human Desire 1

And William Shakespeare: Desire

268 See Gnosis

269 Emmanuel Levinas, *Otherwise Than Being or Beyond Essence*, trans. Alphonso Lingis (The Hague: Martinus Nijhoff, 1981), 205.

270 Emmanuel Levinas, *Otherwise Than Being or Beyond Essence*, trans. Alphonso Lingis (The Hague: Martinus Nijhoff, 1981), 197.

271 Emmanuel Levinas, *Existence and Existents*, trans. Alphonso Lingis (The Hague: Martinus Nijhoff, 1978), 58–60.

The word praxis is from Ancient Greek: πρᾶξις, romanized: praxis. In Ancient Greek the word praxis (πρᾶξις) referred to activity engaged in by free people. The philosopher Aristotle held that there were three basic activities of humans: theoria (thinking), poiesis (making), and praxis (doing). Corresponding to these activities were three types of knowledge: theoretical, the end goal being truth; poetical, the end goal being production; and practical, the end goal being action. See Praxis (Origins)

272 See 2.4.3 The Saying and the Said at Levinas (Stanford)

Also, (Levinas, Otherwise Than Being or Beyond Essence, 1981), page 43

273 Lisa Guenther, "Nameless Singularity: Levinas on Individuation and Ethical Singularity," *Epoché: A Journal for the History of Philosophy* 14, no. 1 (2009): 184–85.

Thomas Berns and Asja Szafraniec, "Levinas and the Question of the 'Political'," in *The Oxford Handbook of Levinas*, ed. Michael L. Morgan (Oxford: Oxford University Press, 2019), 565.

274 Emmanuel Levinas, *Otherwise Than Being or Beyond Essence*, trans. Alphonso Lingis (The Hague: Martinus Nijhoff, 1981), 22–23.

275 Emmanuel Levinas, *Otherwise Than Being or Beyond Essence*, trans. Alphonso Lingis (The Hague: Martinus Nijhoff, 1981), 64.

276 Emmanuel Levinas, *Otherwise Than Being or Beyond Essence*, trans. Alphonso Lingis (The Hague: Martinus Nijhoff, 1981), 61.

277 William Fish, *Philosophy of Perception: A General Introduction* (New York: Routledge, 2010), 82.

See Husserl on Hallucination: A Conjunctive Reading.

278 Dan Zahavi, *Husserl's Legacy: Phenomenology, Metaphysics, and Transcendental Idealism* (Oxford: Oxford University Press, 2017), 54.

See Epoché, perceptual noema, hýle, time-consciousness and phenomenological reduction

279 Friedrich Nietzsche, *Thus Spake Zarathustra*, trans. Thomas Common (New York: Modern Library, 1917), 75–76.

See Thus Spake Zarathustra: First Part, XXII. The Bestowing Virtue

280 Josef Parnas and Mads Gram Henriksen, "Disordered Self in the Schizophrenia Spectrum," *World Psychiatry* 13, no. 3 (October 2014): 222.

Disturbance of Minimal Self (Ipseity) in Schizophrenia: Clarification and Current Status.

281 Emmanuel Levinas, *Otherwise Than Being or Beyond Essence*, trans. Alphonso Lingis (The Hague: Martinus Nijhoff, 1981), 166–67.

282 Thomas Aquinas, *Summa Theologiae*, I, q. 4, a. 2.

See 3.13 Developing Aquinas' Missing Metaphysical Concept of God Today: Ipsa Essentia Subsistens as Infinite Self-Fulfillment Itself.

283 Emmanuel Levinas, *Otherwise Than Being or Beyond Essence*, trans. Alphonso Lingis (The Hague: Martinus Nijhoff, 1981), 132.

284 See E. E. Cummings

285 Emmanuel Levinas, *Otherwise Than Being or Beyond Essence*, trans. Alphonso Lingis (The Hague: Martinus Nijhoff, 1981), 13–14.

286 Levinas, Otherwise Than Being or Beyond Essence, 1981, p. 72

287 (Levinas, Otherwise Than Being or Beyond Essence, 1981), page 213

288 (Levinas, Otherwise Than Being or Beyond Essence, 1981), page 213

289 Emmanuel Levinas, *Otherwise Than Being or Beyond Essence*, trans. Alphonso Lingis (The Hague: Martinus Nijhoff, 1981), 112–13.

290 Emmanuel Levinas, *Otherwise Than Being or Beyond Essence*, trans. Alphonso Lingis (The Hague: Martinus Nijhoff, 1981), 167–68.

291 Emmanuel Levinas, *Otherwise Than Being or Beyond Essence*, trans. Alphonso Lingis (The Hague: Martinus Nijhoff, 1981), 93.

292 Emmanuel Levinas, *Otherwise Than Being or Beyond Essence*, trans. Alphonso Lingis (The Hague: Martinus Nijhoff, 1981), 163.

293 Emmanuel Levinas, *Otherwise Than Being or Beyond Essence*, trans. Alphonso Lingis (The Hague: Martinus Nijhoff, 1981), 163.

294 Emmanuel Levinas, *Otherwise Than Being or Beyond Essence*, trans. Alphonso Lingis (The Hague: Martinus Nijhoff, 1981), 163.

295 Emmanuel Levinas, *Otherwise Than Being or Beyond Essence*, trans. Alphonso Lingis (The Hague: Martinus Nijhoff, 1981), 163.

296 Emmanuel Levinas, *Otherwise Than Being or Beyond Essence*, trans. Alphonso Lingis (Pittsburgh: Duquesne University Press, 1998), 163–64.

297 Emmanuel Levinas, *Otherwise Than Being or Beyond Essence*, trans. Alphonso Lingis (Pittsburgh: Duquesne University Press, 1998), 164.

298 Emmanuel Levinas, *Otherwise Than Being or Beyond Essence*, trans. Alphonso Lingis (The Hague: Martinus Nijhoff, 1981), 102–3.

299 Emmanuel Levinas, *Otherwise Than Being or Beyond Essence*, trans. Alphonso Lingis (The Hague: Martinus Nijhoff, 1981), 215–18.

300 Jacques Derrida is the primary postmodern philosopher associated with "erasure" or overstriking (sous rature) words like "universal," "truth," or "being." This technique signals that a word is necessary for language yet

inadequate or deceptive, challenging the stability of traditional philosophical concepts.

301 Emmanuel Levinas, *Otherwise Than Being or Beyond Essence*, trans. Alphonso Lingis (The Hague: Martinus Nijhoff, 1981), 237.

302 Emmanuel Levinas, *Otherwise Than Being or Beyond Essence*, trans. Alphonso Lingis (The Hague: Martinus Nijhoff, 1981), 238.

303 Emmanuel Levinas, *Otherwise Than Being or Beyond Essence*, trans. Alphonso Lingis (The Hague: Martinus Nijhoff, 1981), 281–2.

304 Emmanuel Levinas, *Otherwise Than Being or Beyond Essence*, trans. Alphonso Lingis (The Hague: Martinus Nijhoff, 1981), 285–6.

305 See Illeity

306 Emmanuel Levinas, *Otherwise Than Being or Beyond Essence*, trans. Alphonso Lingis (The Hague: Martinus Nijhoff, 1981), 287–9.

3

Phusis: Towards Radical Exteriority as Philosophy

Levinas prefers to think of philosophy as the “wisdom of love” rather than the “love of wisdom” (the usual translation of the Greek term “φιλοσοφία”). In his view, responsibility toward the Other (Autrui) precedes any "objective searching after truth". As we have seen, for Levinas, the inter-human relation—referred to as the “face-to-face” relation—is a central philosophical issue. Love plays a foundational role in this relation, shaping our ethical and political interactions with others. Levinas recognizes the significance of erotic love for the subject and, ultimately, for inter-human relations. His description of erotic love and the caress indicates an interlacing of egoistic pleasure and selfless engagement with the other in the sexual relation. He also writes of love for one’s neighbor, paternal love, and even the likens the love of God to the relation to the other. [1] Here are some quotes from Levinas on love: [2]

> “Faith is not a question of the existence or non-existence of God. It is believing that love without reward is valuable.” (Emmanuel Levinas, *Difficult Liberty: Essays on Judaism*, trans. Sean Hand[3]
>
> “To approach the Other in conversation is to welcome his expression, in which at each instant he overflows the idea a thought would carry away from it. It is therefore to receive from the Other beyond the capacity of the I, which means exactly: to have the idea of infinity. But this also means: to

be taught. The relation with the Other, or Conversation, is a non-allergic relation, an ethical relation; but inasmuch as it is welcomed, this conversation is a teaching. Teaching is not reducible to maieutics [as a midwife]; it comes from the exterior and brings me more than I contain. In its non-violent transitivity, the very epiphany of the face is produced." [4]

"I will say this quite plainly, what truly human is - and don't be afraid of this word - love. And I mean it even with everything that burdens love or, I could say it better, responsibility is actually love, as Pascal said: 'without concupiscence' [without lust]… love exists without worrying about being loved." [5]

"For others, in spite of myself, from myself." [6]

"Au moment même où tout est perdu, tout est possible." (Translation: "At the very moment when everything is lost, everything is possible.") [7]

"Love remains a relation with the Other that turns into need, transcendent exteriority of the other, of the beloved. But love goes beyond the beloved… The possibility of the Other appearing as an object of a need while retaining his alterity, or again, the possibility of enjoying the Other… this simultaneity of need and desire, or concupiscence and transcendence, constitutes the originality of the erotic which, in this sense, is the equivocal par excellence." [8]

"If one could possess, grasp, and know the other, it would not be other." [9]

"The very relationship with the other is the relationship with the future." [10]

"Politics is opposed to morality, as philosophy to naivete." [11]

"Memory as an inversion of historical time is the essence of interiority." [12]

"Of course we do not live in order to eat, but it is not really true to say that we eat in order to live; we eat because

we are hungry. Desire has no further intentions behind it... it is a good will." [13]

"A miracle entails a degree of irrationality-not because it shocks reason, but because it makes no appeal to it." [14]

"What could an entirely rational being speak of with another entirely rational being?" [15]

I have been young and now I suppose I am considered old at 69 years old. I have lived through and embodied love as a young man and as an older man. I understand and hold dearly the passions of love I had in my youth, the excitement, the joy, and the desire. But through hard knocks I have found out what derails love and also the kind of love that lasts waking up every morning after decades of marriage still filled with passion, excitement, and joy and also filled with contentment and commitment which is always fresh and deeply meaningful.

Mature love gives these ideas an affective and meaningful context. The first thing that must go to have mature love is thinking you are always right, not really listening to your lover, and being able to say the simple words humbly and sincerely, "I am sorry". When you do not have to be insecure or take offense at these things there is a kind of real peace in letting go. Even more, when you can sincerely empathize and understand your lover's pain, you take it on as your own, as what Levinas refers to as expiation. You suffer for them and with them. There is a comfort in sharing each other's joy and pain which, as Levinas might write, increases indebtedness "*as an infinition of the infinite, as glory*". [16]

THE FOUR LOVES

I want to discuss the four ancient Greek words for love. Love is a concept that has thoroughly confused philosophers for ages. For philosophers, Hegel is much easier to comprehend than love. The Greeks' reflection on love confused us from the beginning by

compounding love into loves. The four words for love in ancient Greek were: *agápe*, *éros*, *philía*, and *storgē*.

Agápe (ἀγάπη) is unconditional love. It has been used to refer to the love of a parent for a child or for a spouse. It was used in Christianity for God's love.

Éros (ἔρως) is passionate love. It is sensual desire or longing. It does not have to be erotic love. According to Plato it can initially be a feeling, but it can also see beauty in a person. It can also go beyond that to the appreciation of beauty itself. Éros helps the soul recall the knowledge of beauty. It also helps us understand spiritual truth. Erotic-based love aspires to the non-corporeal, spiritual plane of existence; that is, finding its truth, just like finding any truth, leads to transcendence. Lovers and a very few philosophers seek truth through éros. For Plato éros is the ideal form of youthful beauty. For the Greeks, éros leads to the uncreated, the lack of origin and genealogy.

Philía (φιλία) is friendship. It can also be affection. Aristotle thought philía was dispassionate virtuous love. It demonstrates loyalty.

Storgē (στοργή) means affection. It is the natural affection in family. [17]

All four loves co-arise, budding branches of the same tree. The roots of this tree are sunk below in excess exteriority. *Agápe* is unconditional love. This is love which goes out towards another and never returns unto itself.

For me, what is compelling about Orpheus' gaze is unconditional love. The gaze of Orpheus has been interpreted by many philosophers:

- Another interpretation or usage of the gaze of Orpheus is by Geoffrey Sirc (1953-). Sirc uses Orpheus's moment of violation as argument for creative form in writing versus the standard polished text. Urging the adolescent writer to break free of formal notions of form, Sirc views the

journal as the media through which Orpheus yearns for Eurydice. Sirc suggests that if "the Work is freed of concern, the gaze is transgressive, then we're clearly not talking about the polished text, especially one oriented dutifully around the tiny truths available through an analysis of middle-brow media." Sirc's primary reference to this is in Kurt Cobain's Journals. [18]

- Jacques Lacan's (1901-1981) perspective on the gaze of Orpheus is more a matter of desires and yearning. On one hand we have Orpheus gazing towards the underworld, which serves to dissolve the connection between Orpheus and his desire, Eurydice. On the other hand, Orpheus' role in the upper world is to use his creativity and artistic talent to transform his desires into a recreated form. Lacan uses the topography of the myth to construct his mirror stage. Mark Linder suggests: "The mirror stage is not an isolated event or situation that results in a particular configuration of vision: it is both a loss (of primordial polymorphous, autoerotic wholeness) and an 'achieved anxiety' (a precocious anticipation of an impossible maturity or return to wholeness." [19]
- Maurice Blanchot (1907-2003) uses the myth of Orpheus to explore the non-dialectical movement of art, particularly literature's self-realization. Unlike Hegelian dialectics, where synthesis leads to a higher truth, Blanchot's Orpheus sacrifices Eurydice but does not attain the work itself. Instead, he affirms the impossibility that underpins the work's origin. Orpheus's gaze upon Eurydice becomes a symbol of the necessity of obliqueness and indirection when approaching existence. Blanchot draws inspiration from Martin Heidegger's concept of "The Origin of the Work of Art," emphasizing that the work is primarily hidden, shrouded in darkness, and only reveals itself through concealment. Blanchot

> understands Eurydice's disappearance as symbolizing a loss, which is compensated for by Orpheus's song—a creative act that transcends mere representation. Blanchot believes that the myth exemplifies the need for indirect approaches to truth and being. 20

Orpheus' gaze of Eurydice must go under never to return to life, to Orpheus. But Orpheus loves her unconditionally even without her presence. Eurydice will go under into Orpheus' heartbreaking pain for the rest of his life, but it will not diminish his love for her. To the contrary, in absence his heart grows fonder. Any parent that has had their child become a young adult will understand the heartbreak of losing 'my baby' during their adolescence. And for those of us who never got to see our child grow up - no one can imagine that pain. Unconditional love marks the place of love which cannot return except as a fullness which grows in absence. And what does *Eros* tell us? Plato writes about Socrates' speech in the "Symposium",

> "What then is Love?" I asked; "Is he mortal?" "No." "What then?" "As in the former instance, he is neither mortal nor immortal, but in a mean between the two." "What is he, Diotima?" "He is a great spirit (daimon), and like all spirits he is intermediate between the divine and the mortal." "And what," I said, "is his power?" "He interprets," she replied, "between gods and men, conveying and taking across to the gods the prayers and sacrifices of men, and to men the commands and replies of the gods; he is the mediator who spans the chasm which divides them, and therefore in him all is bound together, and through him the arts of the prophet and the priest, their sacrifices and mysteries and charms, and all, prophecy and incantation, find their way. For God mingles not with man; but through Love. all the intercourse, and converse of god with man, whether awake or asleep, is

carried on. The wisdom which understands this is spiritual; all other wisdom, such as that of arts and handicrafts, is mean and vulgar.

He is by nature neither mortal nor immortal, but alive and flourishing at one moment when he is in plenty, and dead at another moment, and again alive by reason of his father's nature. But that which is always flowing in is always flowing out, and so he is never in want and never in wealth; and, further, he is in a mean between ignorance and knowledge. The truth of the matter is this: No god is a philosopher. or seeker after wisdom, for he is wise already; nor does any man who is wise seek after wisdom. Neither do the ignorant seek after Wisdom. For herein is the evil of ignorance, that he who is neither good nor wise is nevertheless satisfied with himself: he has no desire for that of which he feels no want." "But-who then, Diotima," I said, "are the lovers of wisdom, if they are neither the wise nor the foolish?" "A child may answer that question," she replied; "they are those who are in a mean between the two; Love is one of them. For wisdom is a most beautiful thing, and Love is of the beautiful; and therefore Love is also a philosopher: or lover of wisdom, and being a lover of wisdom is in a mean between the wise and the ignorant. [21]

Eros is erotic love and excess to erotic love. *Eros* is "*neither mortal nor immortal, but in a mean between the two*". *Eros* is misty, not fully inhabiting binary dualisms but playing with them. *Eros* is something other. As such, *Eros* interprets and spans the chasm which divides. *Eros* binds together all the oppositions of history's narratives in jest and fun. The gods do not mingle directly with humans but through only through their intercourse of love, one moment awake and the same next moment asleep. Dare we think of the play? Socrates tells us wisdom is spiritual. The Greek word for "spiritual" in the phrase "*The wisdom which understands this is*

spiritual" is "*δαίμων*" (pronounced daimon or daemon). A daimon is a lesser divinity or spirit that exists in the space between mortals and gods. It embodies a liminal state, sharing characteristics with both humans and deities. These daimones are often personifications of abstract concepts or forces of *phusis*. They can also be akin to spirit guides, chthonic heroes, or even the deities themselves. Plato's dialogues frequently mention the daimon, emphasizing its role as an intermediary between the divine and the human. The Symposium itself provides a succinct description of the daimon's role:

> "The daimonic … interprets and carries over to the gods things from men, and to men things from the gods, from the one prayers and sacrifices, and from the other orders and rewards for sacrifice. It fills the space between both and thus binds the all to itself." 22

Essentially, the daimon acts as an interpreter, bridging the gap between human and divine realms – binary dualisms. It facilitates communication, guiding humans toward the divine order that remains hidden from their direct perception. It cannot come to presence or its 'not' of absence but exceeds them. But here is "*the evil of ignorance*", *Eros* is "*neither mortal nor immortal*", "*alive and flourishing at one moment when he is in plenty, and dead at another moment*". *Eros "is always flowing in is always flowing out, and so he is never in want and never in wealth; and, further, he is in a mean between ignorance and knowledge*". *Eros "is neither good nor wise*", prior to narrative and also "*Love is of the beautiful; and therefore Love is also a philosopher: or lover of wisdom, and being a lover of wisdom is in a mean between the wise and the ignorant*". The excess of love is both wise and ignorant, not yet collapsed, not yet branching from the observer effect of classicism but on the verge.

Storgē is the love of family. It is the bond which first becomes responsibility for the Other (Autrui) of radical alterity. *Storgē* can

also be the love between parents and their children. *Storgē* is a deep appreciation of inner beauty. It can also be used to describe the love for one's country or even a sports team. *Storgē* is the beginning of community. [23]

Philía as understood in the context of ancient Greek philosophy, goes beyond mere friendship. It represents a sincere and platonic bond that develops through shared experiences, mutual respect, and appreciation. Unlike the physical attraction epitomized by *Eros*, *Philía* encompasses the deeper connections formed between free individuals. These connections can include intimacy and are not limited to conventional friendships. Plato, in his dialogues, explored the nature of *philía*, recognizing that it could extend beyond what we commonly think of as friendship. *Philía* is friendship but also mutual respect and appreciation. This is the possibility for significance in community where community can have an intimacy in which friends have commitment and responsibility to each other partially based on shared experiences. [24] But all these loves are about different ways of love which roam, coming together or falling apart. Love reflects a split which cannot be bridged, taken as projective echo, or disregarded from its necessity. Love desires and sinks below desire. Love wants and needs but remains love in absence, not becoming, not complete, torn and strewn over its many longings.

In Plato's Symposium, Aristophanes makes a speech about the original human. He said that the original human was androgynous, a combination of male and female. In the Symposium Aristophanes states, "*the primeval man was round, his back and sides forming a circle; and he had four hands and the same number of feet, one head with two faces, looking opposite ways, set on a round neck and precisely alike; also, four ears, two privy members, and the remainder to correspond. He could walk upright as men now do, backwards or forwards as he pleased, and he could also roll over and over at a great pace, turning on his four hands and four feet, eight in all, like tumblers going over and over with their legs in the air; this was when he wanted*

to run fast". However, these androgynous beings became a threat to the gods. Aristophanes says of them that "*Terrible was their might and strength, and the thoughts of their hearts were great, and they made an attack upon the gods; of them is told the tale of Otys and Ephialtes who, as Homer says, attempted to scale heaven, and would have laid hands upon the gods*". Rather than kill humans, Aristophanes tells us that Zeus decided to split these being into two, male and female. Zeus thought if this did not work, he might split them again so they would "hop about on a single leg". Aristophanes notes that,

> "After the division the two parts of man, each desiring his other half, came together, and throwing their arms about one another, entwined in mutual embraces, longing to grow into one, they began to die from hunger and self-neglect, because they did not like to do anything apart; and when one of the halves died and the other survived, the survivor sought another mate, man or woman as we call them,–being the sections of entire men or women,–and clung to that." 25

After this, Zeus made some more modifications by putting the genitals on the front of the human being instead of the rear – design mishap according to some. He also made it possible for humans to regenerate with the new arrangement of genitalia. Aristophanes tells us that this created an ancient desire for us to complete ourselves in the opposite gender.

> "So ancient is the desire of one another which is implanted in us, reuniting our original nature, seeking to make one of two, and to heal the state of man." 26

For Aristophanes, the conclusion is,

> And such a nature is prone to love and ready to return love, always embracing that which is akin to him. And when one

of them meets with his other half, the actual half of himself, whether he be a lover of youth or a lover of another sort, the pair are lost in an amazement of love and friendship and intimacy, and one will not be out of the other's sight, as I may say, even for a moment: these are the people who pass their whole lives together, and yet they could not explain what they desire of one another. For the intense yearning which each of them has towards the other does not appear to be the desire of lover's intercourse, but of something else which the soul of either evidently desires and cannot tell, and of which she has only a dark and doubtful presentiment.

Suppose Hephaestus, with his instruments, to come to the pair who are lying side by side and to say to them, 'What do you mortals want of one another?'

They would be unable to explain. And suppose further, that when he saw their perplexity he said: 'Do you desire to be wholly one; always day and night in one another's company? for if this is what you desire, I am ready to melt and fuse you together, so that being two you shall become one, and while you live live a common life as if you were a single man, and after your death in the world below still be one departed soul, instead of two–I ask whether this is what you lovingly desire and whether you are satisfied to attain this?'–

There is not a man of them who when he heard the proposal would deny or would not acknowledge that this meeting and melting into one another, this becoming one instead of two, was the very expression of his ancient need.

And the reason is that human nature was originally one and we were a whole, and the desire and pursuit of the whole is called love. There was a time, I say, when we were one, but now because of the wickedness of mankind God has dispersed us, as the Arcadians were dispersed into villages by the Lacedaemonians. And if we are not obedient to the gods,

there is a danger that we shall be split up again and go about in basso-relievo, like the profile figures showing only one half the nose which are sculptured on monuments, and that we shall be like tallies. Wherefore let us exhort all men to piety in all things, that we may avoid evil and obtain the good, taking Love for our leader and commander.

Let no one oppose him–he is the enemy of the gods who opposes him. For if we are friends of God and at peace with him we shall find our own true loves, which rarely happens in this world at present. I am serious, and therefore I must beg Eryximachus not to make fun or to find any allusion in what I am saying to Pausanias and Agathon, who, as I suspect, are both of the manly nature, and belong to the class which I have been describing. But my words have a wider application–they include men and women everywhere; and I believe that if our loves were perfectly accomplished, and each one returning to his primeval nature had his original true love, then our race would be happy. And if this would be best of all, the best in the next degree must in present circumstances be the nearest approach to such a union; and that will be the attainment of a congenial love.

Wherefore, if we would praise him who has given to us the benefit, we must praise the god Love, who is our greatest benefactor, both leading us in this life back to our own nature, and giving us high hopes for the future, for he promises that if we are pious, he will restore us to our original state, and heal us and make us happy and blessed.

This, Eryximachus, is my discourse of love, which, although different to yours, I must beg you to leave unassailed by the shafts of your ridicule, in order that each may have his turn; each, or rather either, for Agathon and Socrates are the only ones left. 27

Androgyny is "*prone to love and ready to return love*". "*And when*

one of them meets with his other half, the actual half of himself, whether he be a lover of youth or a lover of another sort, the pair are lost in an amazement of love and friendship and intimacy, and one will not be out of the other's sight, as I may say, even for a moment: these are the people who pass their whole lives together, and yet they could not explain what they desire of one another. For the intense yearning which each of them has towards the other does not appear to be the desire of lover's intercourse, but of something else which the soul of either evidently desires and cannot tell, and of which she has only a dark and doubtful presentiment." Love defies explanation though many have tried. Love laughs at knowledge. We love all our lives but never have a clue about the 'is' of love. Love is beyond physicality. Love tells us something or maybe nothing about the soul which it tramples it to death. But what the something or nothing *is* cannot come to narrative, and history. Its exteriority as alterity, chaos which cannot be bridged, historically demands a bridge. Something or perhaps nothing lurks infinitely deep below the surface which never floats into words. The beauty of ancient Greek androgyny tells us something very significant about language and how history entraps it as gender and sexual identity long before that became 'Woke'. Even more, Zeus screwed up and had to make a revision to put the genitals on the front of the human being instead of the rear although many ancient Greeks might disagree with that epistemology. Wow, I guess the ancient Greek really discovered 'Woke" not wild-eyed radical liberals!

Thus, éros is love that is "*the desire and pursuit of the whole*". According to Hesiod, *Eros* is: "*…the fairest of the deathless gods; he unstrings the limbs [makes the limbs go limp] and subdues both mind and sensible thought in the breasts of all gods and all men.*" [28] Hesiod tells us that Eros was one of the oldest deities, born from Chaos alongside Gaia (the Earth) and Tartarus (the Underworld). *Eros*, the non-generative, *without arche* – an-archy, without origin (remind us of something?), parentless god from Aristophanes is neither divine nor mortal. "*At the beginning there was only Chaos, Night (Nyx),*

Darkness (Erebus), and the Abyss (Tartarus). Earth, the Air and Heaven had no existence. Firstly, black winged Night laid a germless egg in the bosom of the infinite deeps of Darkness, and from this, after the revolution of long ages, sprang the graceful Love (Eros) with his glittering golden wings, swift as the whirlwinds of the tempest. Eros rises from deep, infinite, darkness, darkness which exceeds itself, exceeds light, not born of sperm and egg (virgin birth?). Eros swift, instantaneous as whirlwinds of a tempest, branching from chaos!" [29] If I didn't know better, I would say that the Greeks understood quantum physics but to make us feel better let's call it intuition.

"Eros mated in the deep Abyss with dark Chaos, winged like himself, and thus hatched forth our race, which was the first to see the light." [30] Later Eros is spoken of as the child of night (Nyx). He is also spoken of as the son of Aphrodite,

> **[Hera addresses Athene :] We must have a word with Aphrodite. Let us go together and ask her to persuade her boy [Eros], if that is possible, to loose an arrow at Aeetes' daughter, Medea of the many spells, and make her fall in love with Iason . . .**
>
> **He [Eros] smites maids' breasts with unknown heat, and bids the very gods leave heaven and dwell on earth in borrowed forms.**
>
> **Once, when Venus'son [Cupid, aka Eros] was kissing her, his quiver dangling down, a jutting arrow, unbeknown, had grazed her breast. She pushed the boy away. In fact the wound was deeper than it seemed, though unperceived at first. [And she became] enraptured by the beauty of a man [Adonis].**
>
> **Eros drove Dionysos mad for the girl [Aura] with the delicious wound of his arrow, then curving his wings flew lightly to Olympos. And the god roamed over the hills scourged with a greater fire."** [31]

Wow! Was this pornography according to the Greeks? Let's not think too much about this. I am not so sure women got the better end of this deal judging from the history of patriarchy.

LOVE AND PAIN

All existence and essence rings hollow in the face of love. While I am not a Christian, I certainly find beautiful passages in the Bible. I think of 'the peace that passes all understanding' (Philippians 4:7) which must come at the cost of pain. One of the most beautiful expositions of love is 1 Corinthians 13:

> If I speak in the tongues of men and of angels, but have not love, I am only a resounding gong or a clanging cymbal.
>
> If I have the gift of prophecy and can fathom all mysteries and all knowledge, and if I have a faith that can move mountains, but have not love, I am nothing.
>
> If I give all I possess to the poor and surrender my body to the flames, but have not love, I gain nothing.
>
> Love is patient, love is kind. It does not envy, it does not boast, it is not proud.
>
> It is not rude, it is not self-seeking, it is not easily angered, it keeps no record of wrongs.
>
> Love does not delight in evil but rejoices with the truth.
>
> It always protects, always trusts, always hopes, always perseveres.
>
> Love never fails. But where there are prophecies, they will cease; where there are tongues, they will be stilled; where there is knowledge, it will pass away.
>
> For we know in part and we prophesy in part,
>
> but when perfection* comes, the imperfect disappears.
>
> When I was a child, I talked like a child, I thought like a child, I reasoned like a child. When I became a man, I put childish ways behind me.

Now we see but a poor reflection as in a mirror; then we shall see face to face. Now I know in part; then I shall know fully, even as I am fully known.

And now these three remain: faith, hope and love. But the greatest of these is love. MIT [32]

Here is my pain from love for the son I lost at the age of 20 years old:

To Chris,

This song is dedicated to my dear son Chris. I still carry his heart…

Michael Hedges made E.E. Cumming's poem a song with help from David Crosby and Graham Nash.

[i carry your heart with me(i carry it in]

BY E. E. CUMMINGS

i carry your heart with me(i carry it in
my heart)i am never without it(anywhere
i go you go,my dear;and whatever is done
by only me is your doing,my darling)
i fear
no fate(for you are my fate,my sweet)i want
no world(for beautiful you are my world,my true)
and it's you are whatever a moon has always meant
and whatever a sun will always sing is you
here is the deepest secret nobody knows
(here is the root of the root and the bud of the bud
and the sky of the sky of a tree called life;which grows
higher than soul can hope or mind can hide)
and this is the wonder that's keeping the stars apart [33]
i carry your heart(i carry it in my heart)

To Hear the Song: I Carry Your Heart (YouTube)

To Hear a Reading: I Carry Your Heart With Me by E.E.Cummings - Poetry Reading

This is a song I composed, arranged, and recorded about Chris - Distance (.mp3)

And my daughter, who also had to carry that burden from her youth bravely and courageously without even the benefit of the painful wisdom which can come from age. I also have pain for her having to go through this tragedy. She is the third other in which justice is an impossibility, but neither is it optional.

This is the place where Levinas wants to take us. This is life which gurgles up from the depths which I have discussed throughout this project. Substitution, expiation, the third other are difficult notions in Levinas. In a way his ideas are much more difficult than quantum physics' radical externality and spooky chaos. But his ideas are rooted in experience, Ethics, and love. Not just for the ones we love but for ones we have not loved, not known, neighbors, acquaintances, the homeless we see on the street, the stranger or sojourner, the widow, the dejected by societal norms which have to suffer a silent violence. Whatever we are facing now in the face of radical externality - loving, bereaving, desiring, from depths unseen crying "Ethics" and in the very saying there is hope.

BAD CONSCIENCE

As I mentioned earlier, I want to try to explain Levinas' idea of substitution, expiation, and justice in language which many of us can relate to more easily. How can we relate to what Levinas is telling us about accusation? I want to relate something about myself which I think will apply to many of us. From the time that memory became available to me at a very early age, I have had something happen to me which continued well into my sixties before I really had a handle on what was going on. A recurrent memory and emotion would simply pop up in my mind and emotions. Ranging from the most seemingly insignificant situations to highly significant situations from many decades ago until recently with no relation to why or what I was doing at the time. An embarrassing or even stupid thing I did would just flash into my mind. Immediately, I would get mad at myself all over again for the dumb, insensitive, or hurtful thing I did. Over and over through the years these same situations would pop into my mind. And it is not like I have a great memory for these kinds of things. These situations can be summarized as bad conscience. Perhaps others would just write it off as the other person's fault. I never did that. I always blamed it on me alone for being stupid, wrong, bad etc. Many times, I would even silently and verbally say something like stupid me! But no matter what I was doing these same incidents would almost magically appear over and over again. And again, I would inwardly go through throwing a fit about them *ad infinitum*. In my inability to deal directly with them I developed a practice of denial.

One day not too long ago it occurred to me (and I should have known better) that what was really going on was that I still had hurt and pain from these situations. I soon developed another practice when these situations would poof out of nothingness. Instead of getting mad I would ask myself, where is the hurt and pain you are feeling about this incident? Guess what, one by one these incidents stopped popping up in my brain and emotions. What I figured out was that my anger and disappointment could not

resolve these recurrent situations. It only pushed them temporarily back into my subconscious where they were poised and ready to spring back on me when least expected. The point is I had a kind of secret embarrassment about myself that I thought was unique to me. And my knee jerk reaction to them was to be angry and disappointed with myself. So, anger and disappointment may have pushed them back temporarily, but that was only a short-term fix. What I really needed to do was face the real enemy – my hurt, pain, and disappointment with myself. In a nutshell, this is the surface phenomenon of what Levinas is trying to get at with his discussion of accusation. My conscience accused me, and I kept getting mad at myself for what I knew was true – I screwed up.

Accusation comes from without. Accusation always begins from my interaction with the other. After accusation confronts me then comes my interpretation of accusation as persecution. At the point of persecution there is a choice between two paths. I can blame the other or I can blame myself. Certainly, I could choose to justify myself, blame the other, hold myself innocent of all charges. I can try the accuser in the court of self and not so surprisingly find myself guilty or not guilty. My choice was to persecute myself. This is probably because I tend to be more of an introvert rather than an extrovert. Had I been more extroverted I could have easily accused the other for my persecution. It could have thought to myself it was all their fault I f***** up. But in either case, all that is really like taking a pill or a drink to postpone the inevitable eternal recurrence of the same - bad conscience. So, accusation brings persecution. This is where we need to begin to understand something much more profound with what Levinas' is trying to tell us. And guess what, when I practice the habit of letting myself feel the pain something else can come to the fore – expiation. In a way I took on the guilt and punishment, digging down into the emotions of hurt and pain of the other. In so doing I practiced expiation. Even more, Levinas is trying to tell us something much more fundamental than guilt and remorse as a psychological affect. Levinas is telling us that

me, the self, is not built up from my own reductionary bootstraps. We branch from radical alterity of the other, the saying of the other which cannot be recuperated into spacetime, historic narrations of the other – my echo of the other in transactionalism.

PRACTICALITY: HOW CAN WE RELATE TO SUBSTITUTION, ACCUSATION, PERSECUTION, AND EXPIATION?

Having had two wonderful, loving children I can say there is no way a lover can ever break your heart like your child. Having a child is an other-worldly kind of love. The ancient Greeks had a special word for it - agápe (ἀγάπη) or unconditional love. If you have children there is no escape – you will have your heart broken, you will suffer pain for them. The most straight forward example of this is when they are on their way to young adulthood, and you have to let go of them as 'my babies'. Ouch, that bites the big one. You want to treat them as your babies their entire lives, but you know that is not the best thing for them. Treating them like babies is for 'me' not for them. For them, I must put aside 'me' and focus on an impossible justice. The impossible wisdom of love as justice imposes necessity on me to feel pain which I know I will never really recover from. I have to let them go for their sake. This hurts badly and for the rest of my life it will be there more or less. This is a case where the other is no longer about me, about my needs and wants but about them even if it hurts me like hell. This is a case of substitution based on justice. I substitute their need and wants for my needs and wants. My devotion to them comes first. Expiation for your children is literally laying your life down for them. Being the first in line to take incoming fire for them and without question. In Levinas the philosophical ideas of substitution, accusation, persecution, and expiation may be a little hard to understand.

I think the practical effect of what Levinas is telling us may seem somewhat distant in our youth. This brings me to the legacy of pain and heartache. As I have gotten older, I have discovered that certain

kinds of emotional events concerning others which I had when I was younger like anger, blame, resentment, bitterness, etc., were not what they seemed through those years. All of us have experienced failures dealing with others which we regret. We wish we could have done or said something differently. We wish we had behaved differently and achieved a different outcome. This is a guilty conscience. We do not want to admit guilt and shame. I have news for younger folks, unless you sear your ability to have a conscience, these experiences will weigh on you more and more as you get older. Denial is like throwing gas on this fire. Regrets will keep getting worse and you will have to put more and more effort into squelching them as you get older. They will pop up when you least expect it. The strategies of denial and frustration with yourself will not vanquish these inopportune moments. And it only gets worse as we age. Even these kinds of experiences are opportunities to learn something about ourselves, to grow, to gain awareness of ourselves and others. There is a richness in being honest with ourself that money cannot buy.

When we are young, we avoid heartache like the plague. In youth, we learn quickly that it is better not to love than to love and have to live through the death of love. These emotional scars are a form of naive fleeing which simply sends pain underground for a while. We really have no choice but to love again because most of us feel like love is not optional. With wisdom and age, we may learn that there is something about the death of love that never dies. When you sign up for love, in a way, you sign your own death certificate. One clear example of this is those that we dearly loved who die before we do, our parents, our siblings, relatives and sometimes our own children.

There is also another kind of denial which is more insidious – unintentionally hurting others. We are all so busy trying to manage life that we can so easily slip into an insensitivity to what others are going through. We may ‘see’ others through the lens of our life’s echoes. We may barely realize that something we did or said

affected another person negatively. Maybe they felt put down, dismissed, pushed into a place that made them uncomfortable. These oversights are also something that our subconscious will replay over and over again with increasing intensity as we get older. Unless we have some kind of pathological narcissistic/anti-social disorder there is something built into us which is indebted to the other person and their well-being. Violating this, even unintentionally, leaves a mark in the subconscious which does not dissipate with time but remains, festers, and requires more and more effort to find temporary relief. I believe this is why many older folks get highly negative or turn to booze or drugs to weld this increasingly heavy load.

But there is a kind of peace, 'making friends with the horror', that can be made with these issues. All these knee-jerk reactions are an attempt to change pain into something which shifts blame to someone or something else. But this does not promote healing. Denial is a habitual practice. To break a habit requires another kind of habitual practice. The first thing to do is to mentally recognize the feeling as pain and heartache not as anger, bitterness, blame. The next thing to do is to let yourself feel the pain. This is not a cure, pain will still be there, but it allows us to find a kind of center in the midst of the pain, a kind of fullness for having the capacity to still feel pain. The fear of pain is much worse than the feeling of pain. The fear of pain hollows out the soul. And pain is there for a reason, to learn wisdom about the other.

But what shall we do? The ol' master said it truly, "*Tis better to have loved and lost than never to have loved at all*". To get old is to come face to face with this heartache. But there is a funny thing about gaining some wisdom along the way, the pain is worth having. The other, the one you loved is no longer 'there' but in a way they still are in the love you hold for them – you carry their heart in your pain of losing them. There is a richness to this that all the transactionalism, power, fame, glory, money can never give you. There is worthwhileness about living and loving that brings

deep pain but also deep joy in the 'having been' which in some odd way still 'is'. There is a contentment or at least a sense of having loved someone and losing them which has a singularity unique to that person. There is an odd kind of fulfillment, even loss one would not trade that experience for anything. It is as if that would betray one's precious love in their absence. This is a debt that cannot be repaid. This is a longing in which,

> The more I answer the more I am responsible; the more I approach the neighbor with which I am encharged the further away I am. This debit which increases is infinity as an infinition of the infinite, as glory. 35

In my opinion Levinas brings to the fore the far-reaching implications of these kinds of pain. Levinas gives us an account which gives a very different account of the self than narratives of classicism, habituated into commonsense, would have us believe. This goes much deeper than the psychology of how all this plays out in our day-to-day practicalities. Levinas finds in these embodied experiences a kind of pre-sensuality which penetrates below all the historic narratives we tell ourselves. We tend to think of ourselves as free agents, rooted in selfhood from biology, from God, from all the narratives of history which give us a feeling of self-creation, of independent beings, free from any necessary relationship with other independent beings. But what if the deep-rooted feeling is totally wrong?

THE IMPOSSIBILITY OF LOVE FOR SELF-CONSCIOUSNESS

The Greek myth of androgyny goes much further than simply biological gender. It goes to the impossibility of love. In Greek mythology, Psyche was the deification of the human soul. She was portrayed in ancient mosaics as a goddess with butterfly wings (because psyche was also the Ancient Greek word for 'butterfly').

The Greek word psyche literally means “soul, spirit, breath, life or animating force”. In the second century a story is told of Eros and Psyche,

> The story tells of the struggle for love and trust between Eros and Psyche. Aphrodite was jealous of the beauty of mortal princess Psyche, as men were leaving her altars barren to worship a mere human woman instead, and so she commanded her son Eros, the god of love, to cause Psyche to fall in love with the ugliest creature on earth. But instead, Eros falls in love with Psyche himself and spirits her away to his home. Their fragile peace is ruined by a visit from Psyche’s jealous sisters, who cause Psyche to betray the trust of her husband. Wounded, Eros leaves his wife, and Psyche wanders the Earth, looking for her lost love. Eventually she approaches Aphrodite and asks for her help. Aphrodite imposes a series of difficult tasks on Psyche, which she is able to achieve by means of supernatural assistance. After successfully completing these tasks, Aphrodite relents and Psyche becomes immortal to live alongside her husband Eros. Together they had a daughter, Voluptas or Hedone (meaning physical pleasure, bliss). 36

Self-consciousness (Psyche) haunted by Love (Eros), wounded from jealousy and betrayal, symbolizing accusation and persecution of the other, wanders the earth. Self-consciousness lost to itself, unable to find itself as itself, is entrapped by the god of love. But the merely human, self-consciousness, can never find love. Only by finding the work of immortality can Psyche achieve the progeny of love. The ‘*is*’ of love, its mortality, cannot ‘*be*’. Only the immortal can find the progeny of love. Self-consciousness is condemned by mortality to ‘*be*’ torn by the inability of love to find its essence in existence. Immortality is the mythos of a radically other in which the self is forever unable to complete itself from itself. Androgyny is

not about gender. The self has no essence, no immortal basis in its own echo. The self arises in accusation, persecution, substitution, and expiation from the radical alterity of the Other (Autrui). Levinas writes of the radical alterity of the Other (Autrui),

> Immemorial, unrepresentable, invisible, the past that bypasses the present, the pluperfect past, falls into a past that is a gratuitous lapse. It can not be recuperated by reminiscence not because of its remoteness, but because of its incommensurability with the present. The present is essence that begins and ends, beginning and end assembled in a thematizable conjunction; it is the finite in correlation with a freedom. Diachrony is the refusal of conjunction, the non-totalizable, and in this sense, infinite. But in the responsibility for the 0ther, for another freedom, the negativity of this anarchy, this refusal of the present, of appearing, of the immemorial, commands me and ordains me to the other, to the first one on the scene, and makes me approach him, makes me his neighbor. It thus diverges from nothingness as well as from being. It provokes this responsibility against my will, that is, by substituting me for the other as a hostage. All my inwardness is invested in the form of a despite-me, for-another. Despite me, for-another, is signification par excellence. And it is the sense of the "oneself," that accusative that derives from no nominative; it is the very fact of finding oneself while losing oneself. 37

The radical alterity of the Other (Autrui), "*Immemorial, unrepresentable, invisible*" cannot '*be*', as the 'my' of reality, mortality, existence - echo. All the pasts of my presence, my mortality, fall into "*gratuitous lapse*" from a past which was not my past. Doomed to wander the earth vainly attempting to *be* "*recuperated by reminiscence*" by its own echo. All the while in saying, I face the "*incommensurability*" other. Self-conscious'

thematization wanders to and fro' in illusion, only ever reaching its own presence as essence and the mirages of its own freedom. Diachrony, the Other (Autrui) whose past is not my past, whose time is not my time, who cannot exist temporally or spatially in my idea, my presumed freedom, in branching as 'me'. Androgyny is not the split of gender, it is a diachrony of time which refuses conjunction. The Other (Autrui) is "*non-totalizable*" which Levinas tells arises as a sense of infinity. Love is embodied shadowing of the radical alterity of the Other (Autrui). Love infinitely yearning never completing itself with the other. The '*is*' can only recuperate and repeat itself like Echo but the excess of love is responsibility. Love is recognition of its inability to be able to '*be*' the other. And yet… -"*the immemorial, commands me and ordains me to the other*". Echo substitutes itself for the other in the allusion of completeness, essence, and Being.

The other is not the origin of history - my story. My idea of the other cannot find the other in me. The vanity of finding the other in me, as my idea of the other, is auto-affection. Jesus is quoted as saying in order to find yourself you must lose yourself and whoever loses themselves for the sake of the other will find themselves (my paraphrase from Matthew 10:39). *Echo* as the beautiful nymph, full of love for Narcissus, loves him to his end and hers. All the while Narcissus only hears his own echo. Narcissus cannot 'see' love, a radical externality to himself. Echo is diachronous to him. Echo loves Narcissus girding him, yearning for him, even to the point of Narcissus ignoring her love for him by turning her into his essence, into echoes of himself. She waits by the stream until he ages and dies and still, she waits and waits until she dies – but at the end, from Echo's corpse a flower grows on the tree of life marking the trace where Narcissus dies. Echo bespelled in love, abandoned as love, as unrequited love lives on in the flowering of love. The myth of Eros and Narcissus is a good analogy for the direction Levinas wants to take us towards the other. However, even beyond the reach of love, responsibility and justice faces us in the alterity of the

Other (Autrui). Infinitely beneath love, unreachably beneath the self, 'me', cannot remain in itself. It has an indebtedness from which we cannot choose.

The radical alterity of the Other (Autrui) - the Other (Autrui) "*has the face of the poor, the stranger, the widow, and the orphan.*" Levinas emphasizes that Ethical experience begins with this encounter preceding any specific rules, principles, commonsense, essence, Concept, and Being. The stranger, the sojourner, the immigrant – here is responsibility where even love cannot *feel* its depths. This other to whom I face who calls forth responsibility. Not as altruism but as debt which cannot be repaid. Infinitely more,

> The more I answer the more I am responsible; the more I approach the neighbor with which I am encharged the further away I am. This debit which increases is infinity as an infinition of the infinite, as glory. [38]

The sojourner is not echo suited for political transaction or neglect. The sojourner exceeds me as an excess which cannot return to myself, my disdain, my rejection. The anti-immigrant fevered pitch in our country is no different from the birth of Jesus - cast out of Nazareth, run out of town by a mob, to be born in a stable in Bethlehem. Conventional ethical commonsense is borne on the whims of the isolated self's discretion, the echo of self to oneself. Levinas' Ethics arises from responsibility facing the exteriority of the Other (Autrui) in which the 'I' arises from indebtedness.

> The Face of the Other. Levinas argues that the Other discloses himself as a face. The face is the "way in which the other presents himself, exceeding the idea of the other in me". "The face approaches with a glance, a word, a gesture or a movement of the whole body. It addresses, expresses an appeal to, and makes demands of the Self". The Other, which reveals himself as a face, touches the self to the very core of

> its being. The look of the Other pierces the heart of the self so that the self cannot evade the Other's call for help, generosity and sacrifice. This look is the look of the poor, the orphan and the widow that begs for mercy and compassion. The presence of the Other that strikes the very being of the self Levinas would call passivity, affectivity, vulnerability, persecution and trauma. [39]

The other is not the 'said' of my idea. The other facing me exceeds the "*idea of the other in me*", might we think 'says me' as pure signifyingness before representation. Pure signifyingness implies the self, me, is not my own but signifies its absolute inability to be able (to be its own origin) - its complete indebtedness to the radical exteriority of the Other (Autrui). The *logos* of alterity, diachrony, cannot be made commensurate with my *logos*. I am answerable from "*Immemorial, unrepresentable, invisible, the past that bypasses the present*", "*incommensurability with the [my] present*".

Even more impossible than branching as self-origin, is the impossibility of justice and the third other. Proximity as radical alterities 'speaking' from diachronous third others makes me responsible for justice, for decision between diachronies, for *logos* not my *logos*. Just as *agápe* cannot return to itself beyond all reaches of notions of love, my obligation to others calls me to decide impossible justice between them. My requirement and impossibility are accusation which I take as persecution. Am I required to mythically die for the sins of the world, to expiate the world – only to get nailed to a cross of impossible responsibility?

Responsibility cannot grasp, cannot echo, cannot return to itself but owes its very self to the Other (Autrui) who faces me. Radical alterity of the Other (Autrui) presences as face[s] of the other coming from a dimension of height, a dimension of transcendence that presents the stranger. [40] The responsibility I owe to others comes back to me as the nymph Echo. The words I speak Echo

beyond my loves, beyond my origin, coming back without her, without excess, anarchically as classicisms, as narratives, as 'words I say' exceeding themselves from exteriority - from her, him, they. The gift of the stranger, the sojourner, the immigrant, the orphan, the destitute – they are the gift of the tree of life.

Can we think - my branch? If so, I cannot observe myself. From saying the other *observes* me. This is the debt I owe which I cannot repay. My own echo does not arouse 'me' into awareness of awareness. Rather the other mythologized in the nymph Echo observes Narcissus who only sees himself. Without the saying/ observation of the other, Narcissus is merely awareness in superposition of the wave function. The il y a of the quantum wave function is horrific awareness which is incapable of branching of its own. Bare awareness without any possibility of branching, of collapse as *seen* or observed – insomnia in the entire, chaotic environment of the quantum wave function can never sleep in perpetuity. The saying of the other is grace beyond all measure.

AWARENESS OF AWARENESS: WHO IS THE OBSERVER?

As has been mentioned, it is far too early to draw any conclusions about consciousness' relationship to the quantum wave function. But ever since the creation of quantum mechanics the very founders of quantum mechanics have openly suspected, speculated, and wrote that there must be some kind of relationship to consciousness. Any conclusions are a long way off – well past any of our lifetimes. So, as my repeated disclaimers on this subject, I am going to make some huge speculations in this section. Namely, if I, self-consciousness, branch in some fashion from the quantum wave function, who is the observer? It cannot be me, since in this scenario, I am the one falling from superposition at birth, through life, to death, returning (but never left) back to the wave function (insert snide remarks about mysticism here) .

Quantum physics has brought us before a spooky exteriority

which may have been intuited throughout history. Quantum physics is compelling us to reconsider our most familiar ideas and beliefs about reality. Quantum physics brings us to an unbridgeable abyss which cannot be bridged by history and commonsense. Similarly, Levinas brings us face to face with radical alterity in which the self does not exist in its own freedom. I am not self-made, self-created or composites from Concept, from soul, from essence, from Being, from substance, from matter and neutrality. Neither am I composites of the 'not' of all these culminating in the totality of nothingness as neutrality. I suppose religious people could tell us that God is the *logos*, the word, as observer of the wave function. Perhaps biocentrists might inform us that spontaneous collapse or branching functions as the observer. Biocentrists believe that intelligence and consciousness are not exclusive to humans but are inherent in various forms of life, including animals, plants, and even ecosystems. However, in either case quantum physics has made it clear that the singular observer, the scientist who conducts the actual experiment, is an indispensable observer. This singularity is an indispensable co-determinate factor in the probability of what is observed. There is something spooky and extremely intimate in the observer effect. This is not the objective and neutral 'nature' of history. And neither is it absolute subjectivity. It is radical excess which cannot rest in our historic and commonsense certainties.

There are no quantum discontinuities in classicism's narratives. There are no spooky disjunctive breaks from relativity's relatedness except perhaps in the nonsensical mathematics of a singularity. General relativity's singularity is simply the place marker for the 'not', what we do not understand and cannot understand. There is no structural undergirding in which we, being, can stand relative to classicisms narratives, exhaustions, and totalizing 'nots'. Throughout classicism, the self has an analogical relatedness relative to God, to essence, to Being, or to Nietzsche's affirmation of "I am that I am" in the face of eternal recurrence of the same. Nothingness, the catacombs of meaning, the absolute 'not' which

seals the final deal are all built upon logical negations whose counter identity depends on identities, as tautological historic narratives. History provides us with metaphysical absolutes, whether it be essence, Being, Concept or neutrality. Relationships to these are then set accordingly in verticali**ty** and/or horizontali**ty** (where the '**ty**'s signify totality). But each in their own fashion finds a field of asymptotic correspondence to their *telos*, their culmination. Similarly, Einstein's relativity also and much more precisely establishes relationships to the absolute speed of light. In all these philosophical historic narratives the 'not' is always ready to totalize retaining themselves as a placeholder for radical excess - looming metaphysical horizons effacing any and all exteriorities. This is totality, reduction to the same, final certainty.

At the end of epochs what survives most from classicism is the absolute 'not' of neutrality and echoes of reactionary fanaticism. Nietzsche recognized this dynamic as the destitution of meaning, as nihilism, as the last man of mediocrity. The 'not' seals the tomb of totality in finality, the impossibility of anything further in saying and resigned to eternal recurrence of the said. This is hollowing out of meaning from the inside. Barely noticeable we find ourselves acclimated to the infinite recesses of neutrality, mere existence, mediocrity, where the ones with the most toys win. Accompanying this is the rise of pathologies, mental illnesses, suicides and the other absolute 'nots' of fanaticism, autocracy, 'wokeness'. When everything is the same everything is nothing. Classicism's narratives have finally brought us once again face-to-face with impending ipseity, the bare flight from *il y a*. Meaning dwindles as,

awareness

(pure signification, a "*passivity more passive still than the passivity*", as *il y a* devoid of responsibility) of

awareness

(ipseity's flight towards self-consciousness into ego) of

awareness

(the exhaustion of epoch as the totality of the 'not' - history's

exhaustion of the unmoved mover, God, Essence, Being, Concept, Absolute – its inability to be able, to face the horror of 'not's nothing)

in lifelong circularity until even echo is undone by *il y a's* horrific, insomniac awareness - death into pure signifyingness without another.

At the beginning of classicism, Aristotle's' unmoved mover moves all, including humans, as actuality. Here noncontradiction reigns supreme. Logic is born from this essence. Aristotle, the unmoved mover moves all, including humans, as actuality. At the end of classicism, neutrality is the absolute which must forever go underground.

We are unaware how history seals us in a totality which makes it very difficult for us to reckon with radical alterity. Historic narratives give us the freedom to retreat into dreams, to flee from pain and sorrow into allusion. Could it be that all our evasions, self-righteousness, anger, bitterness, revenge, and resentments mask pain? Could it be that love with all its beauty and tragedies points away from Narcissus' echo - ever towards Orpheus' other which cannot *be* as mine, as my idea or history's idea? What if radical alterity facing me, holding me responsible, indebted before 'I am that I am', before my world and freedom, my pain and conscience, bring us to an unbridgeable chasm? Could we face accountability before we are even able to be able? If so, perhaps we can begin to understand what Levinas means by substitution, accusation, persecution, and expiation. All our loves and pain bring us irretrievably gaping before a void as our inability to be the master of our fate, to be the neutral substance of a thinking thing – devoid of exteriority.

Is it possible that we are not our own? Do we still want to maintain that classic spacetime, cause and effect, reality, Being, essence… all our favorite confidences in historic narratives, gelled into commonsense, are somehow magically underlying the findings of quantum physics? Do we really want to be an echo of ourselves,

our certainties, our confidences… one without another? The established findings of 20th century quantum physics have made it impossible for us to go back to classicism. It seems undeniable that the spooky exteriority of the quantum wave function is here to stay. Could this affect our deep-rooted philosophical notions which bubble up into commonsense? Doesn't the observer effect inform us that the metaphysic of neutrality is simply a historic abstraction?

Could the observer effect tell us something about ourselves? How could 'I' *be* both the observer and the observed of the quantum wave function? Perhaps this myth depends on the 'how' of observation, my historic narrative of myself. If we are thinking about mind or self-consciousness, 'me here now', in terms of the wave function observer effect, I do not observe myself into being, into classicism. The observer effect is not some kind of absolute solipsism or narcissism of self-creation. This conclusion would be like the physicist who measures a classical particle, observes/ branches together from/in the wave function discovering that he is the particle. The physicist is not a necromancer of himself. This would fall into the camp of everything is relative to me and my perception which would only be the echo of narcissism yet again. In the quantum wave function, information cannot observe itself and thereby 'branch itself' into probable values of a classical particle. This is way too simplistic.

Observation in the wave function is a confluence and a singularity. What do I mean by this? In actualizing, branching, a definite measurement is achieved. But this measurement does not come from a predetermined certainty. In this sense actuality is singular to the observer. I would refer to this singularity as responsibility not as echo. The observer has a responsibility for what is observed. How is the observer observing? What are the conditions under which observation can produce an answer? At some level the underlying *phusis* of quantum mechanics plays a role in self-consciousness and consciousness of other people. How the consciousness is directed, in what context it is taken, certainly has

something to do with pre-judging how the answer may arise. If judgement is what I expect to see, isn't this my own echo in transactionalism then game theory is on, and strategy wins the day. However, if the observer understands how observation preconditions what is to be seen, this is called responsibility. Responsibility has to do with how we see not what we see.

Now, let's think about the other's role in my observation. The wave function does not collapse alone with a single conscious observer. The wave function branches with confluences of others. Observation not only brings about spacetime, cause and effect, the physical universe and nature. It also brings along with it historic narrative, classicism, embodiment, lived biological, emotional, experience – me here now already clothed with reality. This confluence also brings along the other, others, the stranger, lovers, children. But these others in my observation are not my actualization of the Other (Autrui) who faces me. The Other (Autrui) who faces me is a radically other observer than me. The Other (Autrui) who faces me is radically exterior to me the observer. Here again, what is imposed on us in observation is context - how observation preconditions what is to be seen. Here is where pre-judgement conditions what is actual, what is seen. If the physicist in a quantum experiment does not set up the conditions for what is to be seen correctly, nothing will be seen but chaos. Here by chaos what I mean is nonsense, the full environmental bath of the universal[41] wave function. The physicist must exercise extreme rigor setting up the conditions of what is to be seen. This is responsibility. I can take the other to simply be my observation and nothing else. In this case the other has no otherness but only me echoing myself to myself. Or I can take on my responsibility for what becomes actual. Taking on responsibility for what becomes actual is what Levinas calls Ethics.

In the face of others, the third other, my responsibility requires me to make judgements about justice. The other and 'third other' are both radical externalities to me. As such my responsibility for

judging, for justice, imposes a necessity for rendering a decision between two radical externalities. Since it is impossible for me to have a smooth, relativistic understanding of the other, adding another other doubles-down on those impossibilities. Adding many others reaches an asymptotic limit of impossibility in which responsibility cannot withdraw from daunting impossibilities. I come back to my metaphor of the crucifixion of Jesus taking on the sins of the whole world in expiation of the sins of the other. For me, a non-Christian, I can think of no better analogy, mythos, than how responsibility, radical exteriority, and sacrifice of the 'me' bearing the burden of impossible responsibility for justice in the face of the radical alterities can be mythologized. This is the God-Man (Koinē Greek: θεάνθρωπος, romanized: *theánthropos*; Latin: *deus homo*) or what Noah Harari reverses in his book "Homo Deus". Jesus calls himself the "son of man". Jesus is the mortal self encumbered with the instinct for survival just like all of us. But narcissism is not an option. Jesus must not only recognize the radical alterity of the other but also place himself at the pinnacle of impossible justice, expiation for others. The contrary of this expiation is entitlement, of right, of echo, of transactionalism. A lifetime of this kind of habitual irresponsible observation pre-conditions, locks the self ultimately into ipseity as perpetual retreat from *il y a*, from sheer awareness where death cannot die - return to *il y a*. *Il y a* has no capacity to recognize the other. *Il y a* has no capacity for self-consciousness. *Il y a* has no ability for self-origin or self-creation. *Il y a* is incapable of responsibility to radical externality, to the other. In life, awareness of awareness preconditions the 'how' of observation. In the wave function, without branch, there is only spooky quantum haze of awareness – there is no branching as awareness of awareness. In the wave function observer or observed do not fall into life. And awareness, however we imagine it, must have some node of pure signification in the quantum wave function.

What has been shown in the course of this book is that in the spooky, not physical and also not the 'not' of physical, there is no

pre-metaphysical self, essence, Concept, neutrality which gives rise to the quantum wave function. The quantum wave function's universals[42] have some pre-original, anarchic, hazy a-temporal and a-spatial, simultaneous chaos which already anticipated all actualities. The quantum wave function's chaos brings into question every naming of 'is', 'are, 'will be', 'has been', essence, Being, Concept, life and death. However we want to reference the observer effect, the fall into classicism's narratives is not from some imagined self, essence, Being, Concept which would create itself, branch itself as if from some supposed metaphysical essence or reality outside the wave function. Branching as existence, as me, is from the externality of an observer, of the face of externality saying, observing – invocations from the tree of life.

As you can see, the quantum wave function presents a difficulty I and many others, way smarter than me, have struggled to understand, to put into words, to find a common *logos*, as if to reconcile it to some common principle or philosophy. The way I look at this is – this is radical alterity. This is why we are not cogs in a machine. However, this is not a threat. This is the joyous, gracious, everlasting beauty of the gaping abyss we face – who faces us in all the externalities of lovers, children, parents, friends, orphans, widows, prisoners, immigrants. They are the observers which evoke me from the gaping void. They are the ones with whom the self, me, has impossible responsibility for justice. They are the ones to which I am indebted to the point of expiation. This is the tree of life from which I grow (*rhizo-phusis to chaogenesis*) to the face (visage) of the other which has always already interrupted my genesis.

Hasn't quantum physics brought us to this abyss where the absolute '*is*' or its totalizing anti-identity, its 'not', cannot find refuge? Hasn't quantum physics brought us before this gaping void, this excess in which classicism's binary duality's and totalizations can no longer remain within itself before this radical exteriority, before the quantum wave function? When all that remains is

classical history's inability to rouse itself from the 'not', from sealing itself in its narcissistic tomb of anonymity, all that awaits awareness - is *il y a*. The gaping void of the exhaustion of classicism can no longer allow exteriority in the tombstone of the 'not'. What remains of the day after the totality of classicism, exhausts itself - after classicism has been summed up, reduced, to the exhaustion of waking insomnia? *Il y a* pure signification cannot '*be*'. It is without ownness. It is without signifier and signified. It is the void which has no other, no life. It is unobserved pure signification.

Is it possible that we are unable to be able to create ourselves, find our origin, because we cannot observe ourselves from the quantum wave function's chaos – from radical exteriority which cannot be merely an 'it'? [i] In the quantum wave function, awareness of chaos without self-consciousness, *il y a*, cannot be born, collapse, or branch - *Il y a* as pure signification cannot observe itself. The entire quantum wave function is pure signification which has not been assigned a value, has not branched into classicisms. The face of the other, the androgynous mother combined with the father as love, as *agápe*, *éros*, *philía*, and *storgē*, as substitution, accusation, persecution, and expiation falling into being from love, pain, and responsibility. Born already indebted, before recognition is possible – responsible prior to any origin. And crawling towards death, back towards what we never left - the inability to be able. Once again, returning to pure signification, awaiting whom awakens as 'me'. Might this be the arising as growth of the tree of life?

CONCLUSION

In conclusion, life branches as love and justice. Justice seeks after truth. Justice is the pursuit of knowledge in the face of chaos. Justice weighs and balances. Justice requires blindness in the inescapable pursuit of sight. Justice looks for justification, for proof, identity, order, logic, and proportionality. The 'not' of justice is echo. It is the leveling off into the same. It is merciless. It shows

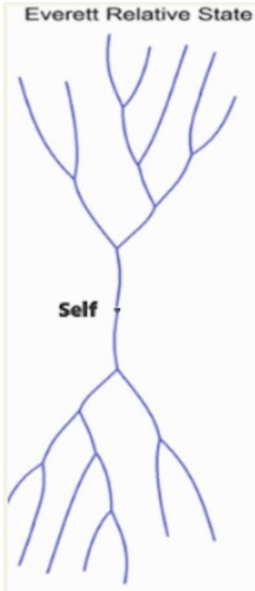
itself as error, incongruence, disorder, contradiction, disproportionate, dogma, and totalitarianism. The 'not' of justice is its depletion, its silence, its error, its inability to be its 'isness'. But the impossibility of justice exceeds the 'not' of justice. Justice cannot find truth. In exceeding the 'not' of justice, impossibility demands justice account for itself, return back to itself, even if only as accusation and persecution, the pangs of what cannot find completion.

Love feels after wholeness. Love yearns for union, emergence, and community. Love requires singularity which cannot remain neutral. The 'not' of love is need and want. Need shows itself as hate, alienation, violence, estrangement, apathy, intolerance, and disdain. But the tragic pain of love exceeds the 'not' of love engulfing both binary polarities of love. In exceeding love, responsibility demands Ethics. But Ethics cannot find satisfaction. Love demands, accuses, and persecutes hollowing itself out in its mortal passivity, its inability as one-for-the-other.

Our androgenous split is not gender, it is unsettled chaos of uncertainty. Psyche falls into self-consciousness as obligation for what cannot come to presence or absence. In narrations of Being and essence, all too mortal wandering the earth in the impossibility but requirement for justice. Love, already accountable, responsible as substitution, accusation, persecution, and expiation. But without reason, without echo, only a gaping void as face, as observer. *Eros* woos from beyond, incapable of mortality, incapable of branching from chaotic exteriority. Nevertheless, impels from still, silent voice. We think, we feel, we live embodied.

Branching, Plato's Forms, Aristotle's unmoved mover have found their way through wandering narratives of history teleologically gaping towards insurmountable uncertainty. Life rending itself as justice and love without origin in the face of unrecoverable exteriority. We bring our truths and passions to life standing on precipice. We see no other side to the chasm before us, so we desire to retreat into dreams. Our brief mortality peers into the bottomless

abyss where even death and Orpheus' gaze cannot fathom. Our life stands momentarily branching, protruding out over chaos. We scream **mortality** only to hear our own echoes reverberating into silence. But below the surface, me in the poverty of ipseity, of signifyingness which must wander to and from over the earth unable to sleep, perchance to impossibly dream, without root, homeless, wanderer, insatiable – exteriority and alterity. These depths plunge bottomlessly towards the wave function and towards Ethics. In this then my life is a branch in which there is inexhaustible hope beyond all imaginable possibilities. Branching of our contingencies grows, ancient - the tree of life. Infinite branching raising our vulnerabilities high, towards the sun, yet rooting, pulsating ever downward, well below the cool darkness of earth - far below the 'nots' and knottiness. Rhizome-ness, growing signifyingness thickening, heightening, swelling spooky, glorious radical exteriority which has no home. Depths which cannot be fathomed but whose vertigo pulls us from beyond life and death in expiation as responsibility for the homeless, the unknown stranger, the widow's pain, the lover's sorrow, the orphan – the other we never knew.



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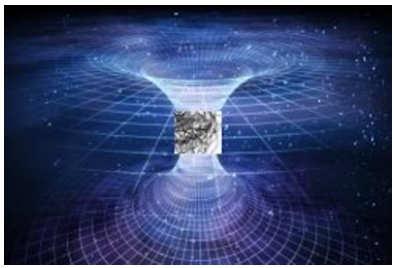

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And 4 - Levinas: Love, Justice and Responsibility

And 4 Levinas: Love, Justice and Responsibility 1

And Levinas and the Wisdom of Love: The Question of Invisibility

2 See Emmanuel Levinas Quotes

And Emmanuel Levinas Quotes 1

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33 See [i carry your heart with me(i carry it in]

34 Mark Randall Dreher, *Untitled Photograph of Two Children and a Dog*, photograph, 2026.

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41 Jacques Derrida is the primary postmodern philosopher associated with "erasure" or overstriking (sous rature) words like "universal," "truth," or "being." This technique signals that a word is necessary for language yet inadequate or deceptive, challenging the stability of traditional philosophical concepts.

42 Jacques Derrida is the primary postmodern philosopher associated with "erasure" or overstriking (sous rature) words like "universal," "truth," or "being." This technique signals that a word is necessary for language yet inadequate or deceptive, challenging the stability of traditional philosophical concepts.

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Mark Dreher, diagram of Everett's relative state formulation, 2026. Image created by the author. Based on Hugh Everett III, "The Theory of the Relative State," in *The Many-Worlds Interpretation of Quantum Mechanics*, eds. Bryce DeWitt and Neill Graham (Princeton: Princeton University Press, 1973), 3–140.

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Image courtesy of Live Science.

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Epilogue: The Precipice of the Other

We have traveled a great distance—from the subatomic uncertainties of the quantum wave function to the vast, holographic boundaries of the cosmos. Throughout this journey, I have demonstrated that the physical world exceeds the asymptotic determinations of classical physics. It refuses to be boxed into the rigid binary of "subject" and "object," or "mind" and "matter." However, we must tread carefully. This excess of meaning—this "quantum weirdness"—should not tempt us into lapsing into some sort of mystic proclamation arising out of mere language or history. Quantum mechanics is not magic; it is a rigorous revelation of limits. It reveals that the "Real" is far stranger and more entangled than our classical intuition ever dared to imagine. To illustrate this one last time, we need only look at the "spooky" observer effect. It is neither purely subjective (in the mind) nor purely objective (in the world). It exceeds both. It is a relationship. It is an entanglement.

I have tried to bring out interesting—and frankly, startling—intersections between this quantum reality and the philosophy of Emmanuel Levinas. But here, at the end of the journey, we must acknowledge a profound hierarchy. Quantum physics clears the brush. It deconstructs the "Totality" of classical determinism. It shows us that the universe is not a clockwork machine. But Levinas brings us an infinite distance further than quantum physics ever can. Physics brings us to the edge of the map, but Levinas places us at the precipice. At this precipice, we find that the "excess" of the universe is not just mathematical "chaos"—it is Ethical Responsibility. The "Other" who faces me is radically exterior to all my reductive, narcissistic echoes. The Other is not a variable in an equation to be solved. The Other is a demand before my choice to

be met.

In the Introduction, I asked if we could escape the Echo of Narcissus. Quantum physics gives us the hint: Entanglement. From the beginning of this work, there was a discussion of similarities between entanglement and love. At this point, we can now ask the question: What does Levinas tell us concerning Love? Emmanuel Levinas does not give a single, sentimental "theory of love." Instead, he radically reinterprets love as an ethical relation, inseparable from responsibility for another person. Across works such as Totality and Infinity (1961) and Otherwise than Being (1974), love is not *primarily* a feeling, choice, or mutual recognition—it is an asymmetrical demand placed on me by the Other.

For Levinas, love is best understood as being responsible for the Other before oneself. He famously writes that responsibility for my neighbor is “the harsh name for what we call love of one’s neighbor.” [1] It does not begin in desire, preference, or shared identity, and it certainly is not grounded in the reciprocity of "I love you because you love me." It precedes freedom and choice entirely; I find myself already responsible. I am answerable to the Other simply because they face me. Levinas locates the origin of this love in the face-to-face encounter, where the Other’s face commands me without force or coercion.

The face is not just a physical appearance but the manifestation of vulnerability and infinity that resists being reduced to an object or concept. In this encounter, the Other implicitly pleads: “Do not kill me. Do not reduce me.” Love appears as our responsiveness to that call. Thus, love is not fusion or possession, but a profound respect for irreducible alterity. Because of this, authentic love is fundamentally unequal. I am responsible for the Other more than they are responsible for me. This asymmetry is essential and non-negotiable. In Otherwise than Being, Levinas intensifies this claim by describing the self as a "hostage" or "substitution" for the Other—someone who bears responsibility even when it is unjust or unreturned. Love does not depend on fairness, it does not wait for

reciprocity, and it freely risks suffering. Ethics—and therefore love—is not a contract.

While Levinas does address erotic love (eros), particularly in Totality and Infinity, he views it as ambiguous. It can turn inward toward mere enjoyment and possession, but it can also disrupt our self-sufficiency, opening the self toward alterity, futurity, and responsibility by revealing the Other as mysterious and unreachable. Yet, eros is not the highest form of love; rather, love is expressed most clearly in relentless care and hospitality—paradigmatically seen in parental love and care for the vulnerable. These forms make visible a responsibility that cannot be measured, completed, or withdrawn. Ultimately, while love begins in this singular responsibility, Levinas insists it must eventually confront the presence of the Third—the other others who also make claims on me. Here, love must be translated into justice and politics, though it must never be erased by those systems. Justice without love becomes cold and violent; love without justice risks blindness.

Quantum physics is the place where classical determinations give way to incredible excess. I have termed this excess "chaos"—not as disorder, but as simultaneously inextricable and inexhaustible. It is the yawning gap of Hesiod, the primordial Chaos from which forms struggle to emerge. But infinitely more than quantum chaos, Levinas finds the self—me—in a frenetic retreat.

We are in flight from the *il y a*, the anonymous, faceless horror of mere existence. To escape this void, the ego enshrouds itself in histories, rationalizations, and justifications—the smoke and mirrors of a self gathering its forces into *phusis*. Yet, in this retreat, the self is suddenly spun around and held responsible to the Other. The Other is a precipice that cannot be brought into my origins or my history. As Levinas writes: "The past of the other, a past that is not my past, but which affects me as though it were my own, is the very essence of responsibility." [2]

Here, we stand at the edge of two vastly different abysses:

Nietzsche, echoing the nobility of tragic history, warns us of the

danger of the void: “He who fights with monsters should look to it that he himself does not become a monster. And if you gaze long into an abyss, the abyss also gazes into you.” [3] For Nietzsche, the abyss gazes back with the meaninglessness of the eternal return of the same. The only defense is a heroic, Greek affirmation—the Echo of Narcissus, whose endless compulsion is to affirm itself against the monstrous void, terrified of being deformed by the very nihilism it opposes.

But Levinas reveals a more shattering precipice. The asymmetry of the void is not the impersonal nothingness of the abyss; it is the visage of the Other. In the face-to-face encounter, the self stares into the yawning gap of its own absolute inability. Here, the masterful ‘I can’ of the ego is stripped away, leaving us in the sheer “inability to be able”. [4] Because the demand of the Other is infinite, the ego is instantly rendered bankrupt—structurally and forever inadequate to fulfill it. When the ego stands in the visage of the Other, it does not just encounter radical alterity; it stares into the void of its own inescapable debt.

Faced with this infinite debt, the self retreats once again. Unable to endure the precipice of the face-to-face, we flee back into the narcissistic shell, hiding behind the totalities of ‘logic’, ‘justice’, and ‘self-preservation’. This retreat into the ego—into the building of histories, the gathering of *phusis*, and the construction of rationalizations—is the self's frantic attempt to bandage the wound opened by the Other. We return to the Echo of Narcissus because standing perpetually at the edge of asymmetrical responsibility is unbearable. We enshroud ourselves in smoke and mirrors to survive the crushing weight of the Face. But this retreat is never clean. It is forever haunted, forever ruined by the memory of the precipice. Because the encounter happened, the Trace remains.

We end, then, not with a unified theory of forces, but with a wounded ego and an asymmetrical relation of responsibility. The "Trace" [5] of the—what shall we say?—particle… wave… neither… defying space and time and the ‘is’ of histories and narratives,

refusing and playing with our intentions. But what of the Trace from the *il y a*, the *there is*, as already responsible before the 'me' of assimilation and history? This trace is not a loss of self to the abyss, but the haunting realization of a self already held accountable to the Other, even as it tries to hide. It is not a romantic symmetry or a cosmic equation to be balanced, but an infinite debt we can never repay, commanded by the face of the widow, the orphan, and the stranger.

And that, finally, is love.

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2 Emmanuel Levinas, *Time and the Other*, trans. Richard A. Cohen (Pittsburgh: Duquesne University Press, 1987), 74.

3 Friedrich Nietzsche, *Beyond Good and Evil: Prelude to a Philosophy of the Future*, trans. Walter Kaufmann (New York: Vintage Books, 1966), §146.

4 Emmanuel Levinas, *Time and the Other*, trans. Richard A. Cohen (Pittsburgh: Duquesne University Press, 1987), 74.

5 Emmanuel Levinas, "The Trace of the Other," trans. Alphonso Lingis, in *Deconstruction in Context: Literature and Philosophy*, ed. Mark C. Taylor (Chicago: University of Chicago Press, 1986), 345-359.

Appendix A (alpha) – Quantum Consciousness References

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Appendix B (beta) - Fragments of Heraclitus

Appendix B (beta) - Fragments of Heraclitus

> “Do not be in too great a hurry to get to the end of Heraclitus the Ephesian’s book: the path is hard to travel. Gloom is there and darkness devoid of light. But if an initiate be your guide, the path shines brighter than sunlight.” (Diogenes Laertius IX, 16) [1]

The extant fragments of Heraclitus (500 BC) have been interpreted in a number of ways throughout history from Plato and Aristotle through later scholarship. Heraclitus is thought to have produced a single book which has never been found. The fragments of Heraclitus which we do have are found in other ancient sources which recite passages of what Heraclitus wrote. Some are older and thought to be more closely aligned with what Heraclitus actually wrote. Ancient reports of the book range from various sayings, epigrams, and aphorisms to having been divided to three sections of cosmology, politics (ethics), and theology. Heraclitus expounds on deep interconnections between science, human affairs, and theology. Note that theology had little to do with modern religions including Christianity but more to do with polytheistic and animistic worship. There are many later interpretations and commentators of Heraclitus partly because we only have around 129 reported fragments of what he wrote. Heraclitus writes his prose in a poetic and rhythmic way. He plays with language to make it sound musical by alliterating the Greek letter ‘π’ in many well-placed words. [2]

Heraclitus thought the first cause was fire. His fragments discuss opposite, unities, flux, strife, and change. He reportedly writes,

panta rhei kai ouden menei
everything flows and nothing abides
all (life is) flux (panta rhei) [3]

Or in other fragments things are *onta* of present participle of being (to be),

In Cratylus 401d we find,
τὰ ὄντα ἰέναι τε πάντα καὶ μένειν οὐδέν
Ta onta ienai te panta kai menein ouden
"All things move and nothing remains still"
The Loeb translation (H.N.Fowler) is "all things move and nothing remains still, and he likens the universe to the current of a river, saying that you cannot step twice into the same river." [4]

His most famous fragment tells us,

ποταμοῖσι τοῖσιν αὐτοῖσιν ἐμβαίνουσιν, ἕτερα καὶ ἕτερα ὕδατα ἐπιρρεῖ.
Potamoisi toisin autoisin embainousin, hetera kai hetera hudata epirrei
"On those stepping into rivers (staying the same), other and other waters flow on." [5]

At times later commentators of Heraclitus seem to understand his writing of oppositions as co-constituent and co-arising as unities. Other times commentators seem to understand his passages as *apparent* unities residing in strife, discord, and enmity. For some he can sound like a mystic and for others as nonsensical. In various ancient references to Heraclitus' fragments we read,

What opposes unites, and the finest attunement stems from things bearing in opposite directions, and all things come

about by strife. 6

Graspings: things whole and not whole, what is drawn together and what is drawn asunder, the harmonious and the discordant. The one is made up of all things, and all things issue from the one. 7

And it is the same thing in us that is quick and dead, awake and asleep, young and old; the former are shifted and become the latter, and the latter in turn are shifted and become the former. 8

Although critical of Homer and Hesiod he appeared to have been influenced to some extent by them. Heraclitus stands at the gap where the more ancient answers no longer sufficed. He bemoans information-gathering as the inability to be able to understand. In the fragment below the "learning of many things" is *polumathiê* in Greek or information-gathering.

The learning of many things does not teach understanding; otherwise, it would have taught Hesiod and Pythagoras, and again Xenophanes and Hecataeus. 9

What does he criticize Hesiod for?

Διδάσκαλος δὲ πλείστων Ἡσίοδος· Τοῦτον ἐπίστανται πλεῖστα εἰδέναι, ὅστις ἡμέρην καὶ εὐφρόνην οὐκ ἐγίνωσκεν· ἔστι γὰρ ἕν.

The teacher of most people is Hesiod. They know he knows the most things, a man who did not know day and night, i.e., that they are one thing. (Heraclitus, *Fragments*, 22B57 (Diels-Kranz).)

Hesiod draws his cosmology from Greek myth poetically. Day and night are independent from each other. They are static and have no dependent relationship to each other. 10

Hesiod treats day and night as gods which pass each other on when they come to earth from their houses. Night is much older than day. Hesiod tells us,

> From Chaos came forth Erebus and black Night; in turn from Night came forth both Day and Aether [11]

So, how does Heraclitus find knowledge different from Hesiod's myth of day and night? He starts by facing what troubles him. What are the inadequacies which find no words in "Hesiod and Pythagoras, and again Xenophanes and Hecataeus". Is Heraclitus bemoaning chaos in Hesiod or the myths which separate day and night?

Heraclitus sees Hesiod's problem in the separation of opposites. Heraclitus tells us,

> And it is the same thing in us that is quick and dead, awake and asleep, young and old; the former are shifted and become the latter, and the latter in turn are shifted and become the former. [12]

Heraclitus has no tolerance for religious ignorance. He does not have any special reverence for gods. He tells us, "*Immortals become mortals, mortals become immortals; they live in each other's death and die in each other's life.*"

Mortals are immortals and immortals are mortals, the one living the others' death and dying the others' life. R. P. 46. [13]

Writing of religious rites of purification, he tells us, "They vainly purify themselves by defiling themselves with blood, just as if one who had stepped into the mud were to wash his feet in mud. Any man who marked him doing thus, would deem him mad." And "And they pray to these images, as if one were to talk with a man's house, knowing not what gods or heroes are."

(129, 130) They vainly purify themselves by defiling themselves with blood, just as if one who had stepped into the mud were to wash his feet in mud. Any man who marked him doing thus, would deem him mad. R. P. 49 a.

(126) And they pray to these images, as if one were to talk with a man's house, knowing not what gods or heroes are. R. P. 49 a. [14]

Heraclitus indicates, “War is the father of all and the king of all; and some he has made gods and some men, some bond and some free.”

Fragment 53

(44) War is the father of all and the king of all; and some he has made gods and some men, some bond and some free. R. P. 34. [15]

Nietzsche tells us that [Heraclitus] denied the duality of totally diverse worlds. [.. .] He no longer distinguished a physical world from a meta-physical one.[. . .] And after this first step, nothing could hold him back from a second, far bolder negation: the—altogether denied being. [...] Heraclitus proclaimed: "I see nothing other than becoming." [16]

and Heraclitus will remain eternally right with his assertion that being is an empty fiction. The "apparent" world is the only one: the "true" world is only added by a lie. [17]

I would suggest that, for Heraclitus, ‘metaphysics’ did not yet exist. He peered from the chaos which preceded him. For Heraclitus the ‘one’ is not privileged over flux. Becoming is not a transformation. It *is* flux itself not the result of flux. He writes us “*panta rhei”* or “all [*is*] flux”. Nietzsche in “Twilight of the Idols” writes,

> With the highest respect, I accept the name of Heraclitus. When the rest of the philosophic folk rejected the testimony of the senses because they showed multiplicity and change, he rejected their testimony because they showed things as if they had permanence and unity. Heraclitus too did the senses an injustice. They lie neither in the way the Eleatics believed, nor as he believed--they do not lie at all. What we make of their testimony, that alone introduces lies; for example, the lie of unity, the lie of thinghood, of substance, of permanence. "Reason" is the cause of our falsification of the testimony of the senses. Insofar as the senses show becoming, passing away, and change, they do not lie. But Heraclitus will remain eternally right with his assertion that being is an empty fiction. The "apparent" world is the only one: the "true" world is merely added by a lie. [18]

All Heraclitus had was the apparent world of chaos, strife, war, death. He summed this up as flux. Heraclitus thinks all is fire. Another fragment indicates, "*That which always was, and is, and will be everlasting fire, the same for all, the cosmos, made neither by god nor man, replenishes in measure as it burns away.*" All is flux. Flux is change without an end, a *telos*. Flux finds no end in becoming. Becoming is not an end itself or a step towards another end. Flux is the end. Strife is both war and peace. Detente is the cooling of war. Progress is an illusion of fire.

> (20) This world, which is the same for all, no one of gods or men has made; but it was ever, is now, and ever shall be an ever-living Fire, with measures of it kindling, and measures going out. [19]

When flux is thought this way, it cannot rise above into rationality and Being. Contradiction is a result of rationality. Heraclitus is not yet 'rational'. Concept can never arise from

Heraclitus. Fire cannot become order. It is mistaken as gods which order the cosmos. Order is a resonance of fire. Heraclitus likens it as a musical note.

Men do not know how what is at variance agrees with itself. It is an attunement of opposite tensions, like that of the bow and the lyre,

> (45) Men do not know how what is at variance agrees with itself. It is an attunement of opposite tensions,[19] like that of the bow and the lyre. R. P. 34.E [20]

Flux for Heraclitus has more to do with chaos than it has to do with order. This shows how seriously Heraclitus takes Hesiod's chaos.

It seems to me that commentators through history have fallen into two camps:

1. strife and opposition
    a. definitive of things, unity (the one)
    b. continuous change culminating contingently in continuity
2. flux and chaos
    a. contradictory
    b. random change and erratic indeterminacy

The strife and opposition camp tend to give way to our sense of continuity. The continuous theme has a sense of temporality which may be thought in terms of:

1. A causal, oppositional past to an effect as momentary present or presence which holds together (e.g. things, the one)

2. A causal, oppositional past and future which effects changes and transforms through moments of resonance.

Flux and change have no necessary effect, no final destination such as unity. This is chaos. Chaos is better shown through Heraclitus' famous 'river fragments'. William Barnes (1801-1886) was a well-known ancient Greek scholar. Barnes tells us Plato reads the famous fragment of Heraclitus as,

> Heraclitus, I believe, says that all things pass and nothing stays, and comparing existing things to the flow of a river, he says you could not step twice into the same river. (Plato Cratylus 402a = A6) [21]

Barnes looks at three other interpretations of Heraclitus from three different fragments we have of Heraclitus' 'river fragments'.

> B12. potamoisi toisin autoisin embainousin hetera kai hetera hudata epirrei.
>
> On those stepping into rivers staying the same other and other waters flow. (Cleanthes from Arius Didymus from Eusebius)
>
> B49a. potamois tois autois …
>
> Into the same rivers we step and do not step, we are and are not. (Heraclitus Homericus)
>
> B91[a]. potamôi … tôi autôi …
>
> It is not possible to step twice into the same river according to Heraclitus, or to come into contact twice with a mortal being in the same state. (Plutarch) [22]

The B12 fragment is believed by scholars to be the fragment which is closest to Heraclitus' original fragment. Barnes tells us that Heraclitus wants to maintain both the idea of chaos and the idea of unity of opposites which co-determine what something is. In the

case of the river, the waters are the same, as in the noun water - what it *is*, and other, as in ever changing or flowing water - as in the verb watering. Water can be static or dynamic. If I step into a river I will never step into the same river as the water is always renewing itself. In other words, something remains what it is by contradicting itself or opposing itself. Something arises out of its destruction or strife. Therefore, a school of thought concerning Heraclitus' *logos* is the determination of strife - the determination of what *is* by what it is not. From a classical perspective,

Chaos has no moment of recognition. Chaos cannot arise to self-reflection, consciousness, a moment of *stasis* (Greek: standing, existence, stability), a unified present. All are smoking mirrors, dreams, phantasms.

Chaos is erratic and random, an appearance with no cohesion.

The continuous theme has a purely contingent account of temporality as a movement in and out of presence embodying its past and moving toward a future coherently. The term coherent here means as information thought as a continual unfolding of nature, of Being, as the truth of existence.

All of these analyses rely on a historic world view which by necessity can only allow a progressive continuity which completes its totalization with negation. This is modeled after the law of noncontradiction. It cannot concede an excess to its absolute denial of externality. From our epoch of Being and truth Heraclitus is like a piece in a puzzle that does not fit but must be twisted and deformed in order to fit or simply tossed from the puzzle. Let's remember that the puzzle of classicism and its progeny modernity did not exist for Heraclitus. Is it possible that he may have peered at daylight which we cannot yet see? [23]

Plato and Aristotle thought that logic as the principle of noncontradiction did not matter much to Heraclitus. Heraclitus did not seem to think much about Homer and Hesiod. He called them fools. Neither did he think much about his contemporaries, including Pythagoras. Nevertheless, he inherited many of their

ideas.

> Heraclitus made every effort to break out of the mold of contemporary thought. Although he was influenced in a number of ways by the thought and language of his predecessors, including the epic poets Homer and Hesiod, the poet and philosopher Xenophanes, the historian and antiquarian Hecataeus, the religious guru Pythagoras, the sage Bias of Priene, the poet Archilochus, and the Milesian philosophers, he criticized most of them either explicitly or implicitly, and struck out on his own path. He rejected polumathiê or information-gathering on the grounds that it "does not teach understanding". He treated the epic poets as fools and called Pythagoras a fraud. [24]

More References:
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Stavros Kouloumentas
Pages 241-259
See Heraclitus Pesseuon: Fragment 52
See THE FRAGMENTS OF HERACLITUS
See HERACLITUS'S PHILOSOPHY AND HEGEL'S DIALECTIC
See Unity in Difference – Difference in Unity: Heraclitus and the Truth of Hermeneutics
See Hegel's Lectures on the History of Philosophy - D. Heraclitus
See Heraclitus (Stanford)
See https://en.wikiquote.org/wiki/Heraclitus
See https://plato.stanford.edu/entries/heraclitus/
as independent see: Kirk 1954, 156; similarly, KRS 1983, 189 and Guthrie 1962, 484

Kirk, G. 1954. Heraclitus: The Cosmic Fragments. Cambridge: Cambridge University Press.

Kirk, G., J. Raven, and M. Schofield. 1983. The Presocratic

Philosophers. 2nd edn. Cambridge: Cambridge University Press (cited as KRS).

Guthrie, W. 1962. A History of Greek Philosophy. vol. 1. Cambridge: Cambridge University Press.

as separate see Kahn 1979, 11

Kahn, C. 1979. The Art and Thought of Heraclitus. Cambridge: Cambridge University Press, 1979).

Nietzsche's 19th century interpretation of Heraclitus' eternally recurring, nihilistic strife of ascending will to power is also anachronistic.

> According to Heraclitean strife, the Greek contest, and Nietzsche's will to power, a balancing out of opposing forces is never achieved, otherwise the struggle which fuels existence would die out. The struggle must never be extinguished; opposing forces must continue the battle, each overcoming the other in turn, for all eternity. This is the way in which the eternal recurrence serves as a prescription for the overman. The will to power, mankind's unrefined animosity and envy, must be acknowledged by the strong individual and transformed from a nihilistic force into one of positive ambition and increase. The eternal recurrence is what the overman strives for within himself; since the rules of eternal becoming, of the contest, do not apply to humanity by nature. Each individual must choose whether to enter into the eternal contest or to extinguish the struggle with his will to power by denying his passions. The eternal recurrence and will to power fit together in that it is the belief in eternal recurrence which gives great individuals the strength to acknowledge the potential of this terrible drive as a source of elevation and increase. 25

Force as the human condition of Newton's second law of motion where force overcomes the stagnant inertia of eternal recurrence of

the same must be the *logos* of will to power.

Heraclitus is not bemoaning something akin to the 19th century neurosis of existential crisis. as giving us more of an account of chaos as original and enduring. [26]

In Heraclitus' later commentators on the 'river fragments', if everything constantly changes there is a flow to these changes which is accomplished by a unity of opposites. Rivers arise from unity and difference. The ways of humankind are divined by eternal strife. For these commentators, chaos cannot be maintained in that rivers cannot be thought of as pure chaos. However, logic had not even been devised yet. At least not as we think of it as the law of non-contradiction. Perhaps these commentators have imported an anachronistic device in maintaining that chaos and the unity of opposites is a contradiction. Was this so for Heraclitus? Later Aristotle in his Metaphysics discusses logic in terms of what we think as the principle of noncontradiction.

> The Most Fundamental Principle of Knowledge: The Law of Non-Contradiction [LNC]
>
> Which principle this is, let us proceed to say. It is this: the same attribute cannot at the same time belong and not belong to the same subject and in the same respect--we must presuppose, to guard against dialectical objections, any further qualifications which might be added.
>
> This, then, is the most certain of all principles, since it answers to the definition given above. For it is impossible for any one to believe the same thing to be and not to be, as some think Heraclitus says. For what a man says, he does not necessarily believe; and if (1) it is impossible that contrary attributes should belong at the same time to the same subject (the usual qualifications must be presupposed in this premise too), and if (2) an opinion which contradicts another is contrary to it, then obviously (3) it is impossible for the same man at the same time to believe the same thing to be and not

to be; for if a man were mistaken on this point he would have contrary opinions at the same time... [27]

Here we clearly see that Aristotle sharply focused logic as adhering to the principle of noncontradiction. However, Aristotle's argument here is primarily against his contemporaneous school of Parmenides' relativism which could not account for change and motion. [28]

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1 See Hegel Reading Heraclitus

2 See Heraclitus Pesseuon Fragment 52

3 See Heraclitus (Information Philosopher)

4 See Heraclitus (Information Philosopher)

5 See Heraclitus (Information Philosopher)

6 See http://heraclitusfragments.com/B8/index.html

7 See http://heraclitusfragments.com/B10/index.html

8 See http://heraclitusfragments.com/B88/index.html

9 See http://heraclitusfragments.com/B40/index.html

10 See https://philarchive.org/archive/LESVFK-2

11 See Heraclitus: Fragments

12 See B88, http://heraclitusfragments.com/files/ge.html

13 See 67 and 62, https://en.wikisource.org/wiki/Fragments_of_Heraclitus

14 See 129, 126, https://en.wikisource.org/wiki/Fragments_of_Heraclitus

15 See 44, https://en.wikisource.org/wiki/Fragments_of_Heraclitus

16 See Nietzsche, Philosophy in the Tragic Age of the Greeks, 4. Becoming and Chaos, or Differance and Chaosmos (.pdf)

17 See Nietzsche, Philosophy in the Tragic Age of the Greeks, 4. Becoming and Chaos, or Differance and Chaosmos (.pdf)

18 See Twilight of the Idols (Chap. 2)

19 See 30, https://en.wikisource.org/wiki/Fragments_of_Heraclitus

20 See Fragments of Heraclitus: Fragment 51

21 See How Did Heraclitus View Of Philosophy

22 See Heraclitus (Stanford)

23 See Heraclitus (Information Philosopher)

24 See Heraclitus (Stanford)

25 See Nietzsche and Heraclitus .

26 See Verbs for Knowing in Heraclitus' Rebuke of Hesiod (DK 22B57) (.pdf)

And Nietzsche and Heraclitus.

27 See Aristotle's METAPHYSICS: Book IV (excerpts)

28 See Plato, Parmenides (137c - 142a)

Appendix Γ (gamma) – Commentaries on Heraclitus

Appendix Γ (gamma) – Commentaries on Heraclitus

Here are some more commentators which have given us more insights into Heraclitus.

> They say that Euripides gave [Socrates] a copy of Heraclitus' book and asked him what he thought of it. He replied: 'What I understand is splendid; and I think that what I don't understand is so too - but it would take a Delian to get to the bottom of it.' (Diogenes Laertius, Lives of the Philosophers) [1]

> At the beginning of his writings on nature, and pointing in some way at the environment, [Heraclitus] says:
>
> Of this account which holds forever men prove uncomprehending, both before hearing it and when first they have heard it. For although all things come about in accordance with this account, they are like tyros as they try the words and the deeds which I expound as I divide up each thing according to its nature and say how it is. Other men fail to notice what they do when they are awake, just as they forget what they do when asleep.
>
> [B 1]
>
> Having thus explicitly established that everything we do or think depends upon participation in the divine account, he continues and a little later on adds:
>
> For that reason you must follow what is common (i.e. what is universal - for 'common' means 'universal'). But although the account is common, most men live as though they had an understanding of their own. [B 2]
>
> (Sextus Empiricus, Against the Mathematicians VII 132) [2]

3.

On the subject of the soul, Cleanthes sets out the doctrines of Zeno [the Stoic] in order to compare them to those of the other natural scientists. He says that Zeno, like Heraclitus, holds the soul to be a percipient exhalation. For, wanting to show that souls as they are exhaled always become new, he likened them to rivers, saying:

On those who enter the same rivers, ever different waters flow - and souls are exhaled from the moist things. [B 12]

Now Zeno, like Heraclitus, says that the soul is an exhalation; but he holds that it is percipient...

(Arius Didymus, fragment 39 Diels,
quoted by Eusebius, Preparation for the Gospel XV xx 2) 3

4.

Heraclitus the Obsure theologizes the natural world as something unclear and to be conjectured about through symbols. He says:

Gods are mortal, humans immortal, living their death, dying their life. [B 62]

And again:

We step and do not step into the same rivers, we are and we are not. [B 49a]

Everything he says about nature is enigmatic and allegorized.

(Heraclitus, Homeric Questions 24.3-5) 4

5.

For it is not possible to step twice into the same river, according to Heraclitus, nor to touch mortal substance twice in any condition: by the swiftness and speed of its change, it scatters and collects itself again - or rather, it is not again and later but simultaneously that it comes together and departs, approaches and retires. [B 91]

(Plutarch, On the E at Delphi 392B) 5

6.

Heraclitus says that the universe is divisible and indivisible, generated and ungenerated, mortal and immortal, Word and Eternity, Father and Son, God and Justice.

Listening not to me but to the account, it is wise to agree that all things are one, [B 50]

says Heraclitus. That everyone is ignorant of this and does not agree he states as follows:

They do not comprehend how, in differing, it agrees with itself - a backward-turning connection, like that of a bow and a lyre. [B 51]

That an account exists always, being the universe and eternal, he says in this way:

Of this account which holds forever men prove uncomprehending, before hearing it ad when first they have heard it. For although all things come about in accordance with this account, they are like tyros as they try the words and the deeds which I expound as I divide up each thing according to its nature and say how it is. [B 1]

That the universe is a child and an eternal king of all things for all eternity he states as follows:

Eternity is a child at play, playing draughts: the kingdom is a child's. [B 52]

That the father of everything that has come about is generated and ungenerated, creature and creator, we hear him saying:

War is the father of all, king of all: some it shows as gods, some as men, some it makes slaves, others free. [B 53]

... That God is unapparent, unseen, unknown to men, he says in these words:

Unapparent connection is better than apparent. [B 54]

He praises and admires the unknown and unseen part of his power above the known part. That he is visible to men and not undiscoverable he says in the following words:

I honour more those things which are learned by sight and hearing, [B 55]

he says - i.e. the visible more than the invisible. <The same> is learned from such words of his as these:

Men have been deceived, he says, as to their knowledge of what is apparent in the same way that Homer was - and he was the wisest of all the Greeks. For some children who were killing lice deceived him by saying: "What we saw and caught we leave behind, what we neither saw nor caught we take with us.' [B 56]

... Heraclitus says that dark and light, bad and good, are not different but one and the same. For example, he reproaches Hesiod for not knowing day and night - for day and night, he says, are one, expressing it thus:

A teacher of most is Hesiod: they are sure he knows most who did not recognize day and night - for they are one. [B 57]

... He says that the polluted and the pure are one and the same, and that the drinkable and the undrinkable are one and the same:

The sea, he says, is most pure and most polluted water: for fish, drinkable and life-preserving; for men, undrinkable and death-dealing. [B 61]

And he explicitly says that the immortal is mortal and the mortal immortal in the following words:

Immortals are mortal, mortals immortals: living their death, dying their life. [B 62]

He also speaks of a resurrection of this visible flesh in which we are born, and he is aware that god is the cause of this resurrection - he says:

There they are said to rise up and to become wakeful

guardians of the living and the dead. [B 63]

And he says that a judgement of the world and of everything in it comes about through fire; for

Fire will come and judge and convict all things. [B 66]

He says that this fire is intelligent and the cause of the management of the universe, expressing it thus:

The thunderbolt steers all things [B 64]

(i.e. directs everything) - by 'the thunderbolt' he means the eternal fire, and he calls it need and satiety.[B 65] (The establishment of the world according to him being need and the conflagration satiety).

In the following passage he has set down all his own thought - and at the same time that of the sect of Noetus, whom I have briefly shown to be a disciple not of Christ but of Heraclitus. For he says that the created universe is itself the maker and creator of itself:

God is day and night, winter and summer, war and peace, satiety and famine; but he changes like olive oil which, when it is mixed with perfumes, gets its name from the scent of each. [B 67]

(Hippolytus, Refutation of All Heresies IX ix 1-x 9) 6

7.

Of those whose accounts I have heard, no-one has come so far as to recognize that the wise is set apart from all things. [B 108]

It is better to hide folly than to make it public. [B 109]

It is not good for me to get all they want. [B 110]

Sickness makes health sweet and good, hunger plenty, weariness rest. [B 111]

To be temperate is the greatest excellence. And wisdom is speaking the truth and acting with knowledge in accordance with nature. [B 112]

Thinking is common to all. [B 113]

Speaking with sense one should rely on what is common to all, as a city on its law and with yet greater reliance. For all human laws are nourished by the one divine; for it is as powerful as it wishes, and it suffices for all, and it prevails. [B 114]

Soul has a self-increasing account. [B 115]

All men can know themselves and be temperate. [B 116]

A man when he is drunk is led by a boy, stumbling, not knowing where he goes, his soul moist. [B 117]

A dry soul is wisest and best. [B 118]

(Stobaeus, Anthology III i 174-180, v 6-8) 7

8.

Surely nature longs for the opposites and effects her harmony from them... That was also said by Heraclitus the Obscure:

Combinations - wholes and not wholes, concurring differing, concordant discordant, from all things one and from one all things. [B 10]

In this way the structure of the universe - I mean, of the heavens and earth and the whole world - was arranged by harmony through the blending of the most opposite principles.

([Aristotle], *On the World* 396b7-8, 20-25) 8

[137c] “I am ready, Parmenides, to do that,” said Aristoteles, “for I am the youngest, so you mean me. Ask your questions and I will answer.”

“Well then,” said he, “if the one exists, the one cannot be many, can it?” “No, of course not.” “Then there can be no parts of it, nor can it be a whole.” “How is that?” “The part surely is part of a whole.” “Yes.” “And what is the whole? Is not a whole that of which no part is wanting?”

[137d] “Certainly.” “Then in both cases the one would

consist of parts, being a whole and having parts." "Inevitably." "Then in both cases the one would be many, not one." "True." "Yet it must be not many, but one." "Yes." "Then the one, if it is to be one, will not be a whole and will not have parts." "No."

"And if it has no parts, it can have no beginning, or middle, or end, for those would be parts of it?" "Quite right." "Beginning and end are, however, the limits of everything." "Of course." "Then the one, if it has neither beginning nor end, is unlimited." "Yes, it is unlimited." "And it is without form,

[137e] for it partakes neither of the round nor of the straight." "How so?" "The round, of course, is that of which the extremes are everywhere equally distant from the center." "Yes." "And the straight, again, is that of which the middle is in the nearest line between the two extremes." "It is." "Then the one would have parts and would be many, whether it partook of straight or of round form." "Certainly." "Then it is neither straight nor round, since it has no parts."

[138a] "Right."

"Moreover, being of such a nature, it cannot be anywhere, for it could not be either in anything else or in itself." "How is that?" "If it were in something else, it would be encircled by that in which it would be and would be touched in many places by many parts of it; but that which is one and without parts and does not partake of the circular nature cannot be touched by a circle in many places." "No, it cannot." "But, furthermore, being in itself it would also be surrounding with itself naught other than itself,

[138b] if it were in itself; for nothing can be in anything which does not surround it." "No, it cannot." "Then that which surrounds would be other than that which is surrounded; for a whole cannot be both active and passive in the same action; and thus one would be no longer one, but

two." "True." "Then the one is not anywhere, neither in itself nor in something else." "No, it is not."

"This being the case, see whether it can be either at rest or in motion." "Why not?"

[138c] "Because if in motion it would be either moving in place or changing; for those are the only kinds of motion." "Yes." "But the one, if changing to something other than itself, cannot any longer be one." "It cannot." "Then it is not in motion by the method of change." "Apparently not." "But by moving in place?" "Perhaps." "But if the one moved in place, it would either revolve in the same spot or pass from one place to another." "Yes, it must do so." "And that which revolves must rest upon a center and have other parts which turn about the center;

[138d] but what possible way is there for that which has no center and no parts to revolve upon a center?" "There is none." "But does it change its place by coming into one place at one time and another at another, and move in that way?" "Yes, if it moves at all." "Did we not find that it could not be in anything?" "Yes." "And is it not still more impossible for it to come into anything?" "I do not understand why." "If anything comes into anything, it must be not yet in it, while it is still coming in, nor still entirely outside of it, if it is already coming in, must it not?" "It must."

[138e] "Now if anything goes through this process, it can be only that which has parts; for a part of it could be already in the other, and the rest outside; but that which has no parts cannot by any possibility be entirely neither inside nor outside of anything at the same time." "True." "But is it not still more impossible for that which has no parts and is not a whole to come into anything, since it comes in neither in parts nor as a whole?" "Clearly."

[139a] "Then it does not change its place by going anywhere or into anything, nor does it revolve in a circle,

nor change." "Apparently not." "Then the one is without any kind of motion." "It is motionless." "Furthermore, we say that it cannot be in anything." "We do." "Then it is never in the same." "Why is that?" "Because it would then be in that with which the same is identical." "Certainly." "But we saw that it cannot be either in itself or in anything else." "No, it cannot." "Then the one is never in the same."

[139b] "Apparently not." "But that which is never in the same is neither motionless nor at rest." "No, it cannot be so." "The one, then, it appears, is neither in motion nor at rest." "No, apparently not."

"Neither, surely, can it be the same with another or with itself; nor again other than itself or another." "Why not?" "If it were other than itself, it would be other than one and would not be one." "True." "And, surely, if it were the same with another, it would be that other, and would not be itself;

[139c] therefore in this case also it would not be that which it is, namely one, but other than one." "Quite so." "Then it will not be the same as another, nor other than itself." "No." "But it will not be other than another, so long as it is one. For one cannot be other than anything; only other, and nothing else, can be other than another." "Right." "Then it will not be other by reason of being one, will it?" "Certainly not." "And if not for this reason, not by reason of itself; and if not by reason of itself, not itself; but since itself is not other at all,

[139d] it will not be other than anything." "Right." "And yet one will not be the same with itself." "Why not?" "The nature of one is surely not the same as that of the same." "Why?" "Because when a thing becomes the same as anything, it does not thereby become one." "But why not?" "That which becomes the same as many, becomes necessarily many, not one." "True." "But if the one and the same were identical, whenever anything became the same it would

always become one, and when it became one, the same." "Certainly." "Then if the one is the same with itself,

[139e] it will not be one with itself; and thus, being one, it will not be one; this, however, is impossible; it is therefore impossible for one to be either the other of other or the same with itself." "Impossible." "Thus the one cannot be either other or the same to itself or another." "No, it cannot." "And again it will not be like or unlike anything, either itself or another." "Why not?" "Because the like is that which is affected in the same way." "Yes." "But we saw that the same was of a nature distinct from that of the one." "Yes, so we did."

[140a] "But if the one were affected in any way apart from being one, it would be so affected as to be more than one, and that is impossible." "Yes." "Then the one cannot possibly be affected in the same way as another or as itself." "Evidently not." "Then it cannot be like another or itself." "No, so it appears." "Nor can the one be so affected as to be other; for in that case it would be so affected as to be more than one." "Yes, it would be more." "But that which is affected in a way other than itself or other,

[140b] would be unlike itself or other, if that which is affected in the same way is like." "Right." "But the one, as it appears, being never affected in a way other than itself or other, is never unlike either itself or other." "Evidently not." "Then the one will be neither like nor unlike either other or itself." "So it seems."

"Since, then, it is of such a nature, it can be neither equal nor unequal to itself or other." "Why not?" "If it is equal, it is of the same measures as that to which it is equal." "Yes." "And if it is greater or less than things

[140c] with which it is commensurate, it will have more measures than the things which are less and less measures than the things which are greater." "Yes." "And in the case of

things with which it is not commensurate, it will have smaller measures than some and greater measures than others." "Of course." "Is it not impossible for that which does not participate in sameness to have either the same measures or anything else the same?" "Impossible." "Then not having the same measures, it cannot be equal either to itself or to anything else." "No, apparently not." "But whether it have more measures or less,

[140d] it will have as many parts as measures and thus one will be no longer one, but will be as many as are its measures." "Right." "But if it were of one measure, it would be equal to the measure; but we have seen that it cannot be equal to anything." "Yes, so we have." "Then it will partake neither of one measure, nor of many, nor of few; nor will it partake at all of the same, nor will it ever, apparently, be equal to itself or to anything else; nor will it be greater or less than itself or another." "Perfectly true."

[140e] "Well, does anyone believe that the one can be older or younger or of the same age?" "Why not?" "Because if it has the same age as itself or as anything else, it will partake of equality and likeness of time, and we said the one had no part in likeness or equality." "Yes, we said that." "And we said also that it does not partake of unlikeness or inequality." "Certainly." "How, then, being of such a nature,

[141a] can it be either younger or older or of the same age as anything?" "In no way." "Then the one cannot be younger or older or of the same age as anything." "No, evidently not." "And can the one exist in time at all, if it is of such a nature? Must it not, if it exists in time, always be growing older than itself?" "It must." "And the older is always older than something younger?" "Certainly." "Then that which grows older than itself grows at the same time younger than itself, if it is to have something than which it grows older." "What do you mean?"

[141b] “This is what I mean: A thing which is different from another does not have to become different from that which is already different, but it must be different from that which is already different, it must have become different from that which has become so, it will have to be different from that which will be so, but from that which is becoming different it cannot have become, nor can it be going to be, nor can it already be different: it must become different, and that is all.” “There is no denying that.”

[141c] “But surely the notion 'older' is a difference with respect to the younger and to nothing else.” “Yes, so it is.” “But that which is becoming older than itself must at the same time be becoming younger than itself.” “So it appears.” “But surely it cannot become either for a longer or for a shorter time than itself; it must become and be and be about to be for an equal time with itself.” “That also is inevitable.” “Apparently, then, it is inevitable that everything which exists in time and partakes of time

[141d] is of the same age as itself and is also at the same time becoming older and younger than itself.” “I see no escape from that.” “But the one had nothing to do with such affections.” “No, it had not.” “It has nothing to do with time, and does not exist in time.” “No, that is the result of the argument.”

“Well, and do not the words 'was,' 'has become,' and 'was becoming' appear to denote participation in past time?” “Certainly.”

[141e] “And 'will be,' 'will become,' and 'will be made to become,' in future time?” “Yes.” “And 'is' and 'is becoming' in the present?” “Certainly.” “Then if the one has no participation in time whatsoever, it neither has become nor became nor was in the past, it has neither become nor is it becoming nor is it in the present, and it will neither become nor be made to become nor will it be in the future.” “Very

true." "Can it then partake of being in any other way than in the past, present, or future?" "It cannot." "Then the one has no share in being at all." "Apparently not." "Then the one is not at all." " Evidently not." " Then it has no being even so as to be one, for if it were one, it would be and would partake of being; but apparently one neither is nor is one, if this argument is to be trusted."

[142a] "That seems to be true." "But can that which does not exist have anything pertaining or belonging to it?" "Of course not." "Then the one has no name, nor is there any description or knowledge or perception or opinion of it." "Evidently not." "And it is neither named nor described nor thought of nor known, nor does any existing thing perceive it." "Apparently not." "Is it possible that all this is true about the one ?" "I do not think so."

"Shall we then return to our hypothesis and see

[142b] if a review of our argument discloses any new point of view?" "By all means." "We say, then, that if the one exists, we must come to an agreement about the consequences, whatever they may be, do we not?" "Yes." "Now consider the first point. If one is, can it be and not partake of being?" "No, it cannot." "Then the being of one will exist, but will not be identical with one; for if it were identical with one, it would not be the being of one, nor would one partake of it,

[142c] but the statement that one is would be equivalent to the statement that one is one but our hypothesis is not if one is one, what will follow, but if one is. Do you agree?" "Certainly." "In the belief that one and being differ in meaning?" "Most assuredly." "Then if we say concisely 'one is,' it is equivalent to saying that one partakes of being?" "Certainly." "Let us again say what will follow if one is and consider whether this hypothesis must not necessarily show that one is of such a nature as to have parts." "How does that

come about ?" "In this way:

[142d] If being is predicated of the one which exists and unity is predicated of being which is one, and being and the one are not the same, but belong to the existent one of our hypothesis, must not the existent one be a whole of which the one and being are parts?" "Inevitably." "And shall we call each of these parts merely a part, or must it, in so far as it is a part, be called a part of the whole?" "A part of the whole." "Whatever one, then, exists is a whole and has a part." "Certainly." "Well then, can either of these two parts of existent one—unity and being—abandon the other?

142e] Can unity cease to be a part of being or being to be a part of unity?" "No." "And again each of the parts possesses unity and being, and the smallest of parts is composed of these two parts, and thus by the same argument any part whatsoever has always these two parts; for always unity has being and being has unity;

[143a] and, therefore, since it is always becoming two, it can never be one." "Certainly." "Then it results that the existent one would be infinite in number?" "Apparently."

"Let us make another fresh start." "In what direction?" "We say that the one partakes of being, because it is?" "Yes." "And for that reason the one, because it is, was found to be many." "Yes." "Well then, will the one, which we say partakes of being, if we form a mental conception of it alone by itself, without that of which we say it partakes, be found to be only one, or many?" "One, I should say."

[143b] "Just let us see; must not the being of one be one thing and one itself another, if the one is not being, but, considered as one, partakes of being?" "Yes, that must be so." "Then if being is one thing and one is another, one is not other than being because it is one, nor is being other than one because it is being, but they differ from each other by virtue of being other and different." "Certainly." "Therefore

the other is neither the same as one nor as being." "Certainly not." "Well, then, if we make a selection among them,

[143c] whether we select being and the other, or being and one, or one and the other, in each instance we select two things which may properly be called both?" "What do you mean?" "I will explain. We can speak of being?" "Yes." "And we can also speak of one?" "Yes, that too." "Then have we not spoken of each of them?" "Yes." "And when I speak of being and one, do I not speak of both?" "Certainly." "And also when I speak of being and other, or other and one, in every case I speak of each pair as both?"

[143d] "Yes." "If things are correctly called both, can they be both without being two?" "They cannot." "And if things are two, must not each of them be one?" "Certainly." "Then since the units of these pairs are together two, each must be individually one." "That is clear." "But if each of them is one, by the addition of any sort of one to any pair whatsoever the total becomes three?" "Yes." "And three is an odd number, and two is even?" "Of course."

[143e] "Well, when there are two units, must there not also be twice, and when there are three, thrice, that is, if two is twice one and three is thrice one?" "There must." "But if there are two and twice, must there not also be twice two? And again, if there are three and thrice, must there not be thrice three?" "Of course." "Well then, if there are three and twice and two and thrice, must there not also be twice three and thrice two?" "Inevitably." "Then there would be even times even,

[144a] odd times odd, odd times even, and even times odd." "Yes." "Then if that is true, do you believe any number is left out, which does not necessarily exist?" "By no means." "Then if one exists, number must also exist." "It must." "But if number exists, there must be many, indeed an infinite multitude, of existences; or is not number infinite in

multitude and participant of existence?" "Certainly it is." "Then if all number partakes of existence, every part of number will partake of it?" "Yes."

[144b] "Existence, then, is distributed over all things, which are many, and is not wanting in any existing thing from the greatest to the smallest? Indeed, is it not absurd even to ask that question? For how can existence be wanting in any existing thing?" "It cannot by any means." "Then it is split up into the smallest and greatest and all kinds of existences nothing else is so much divided,

[144c] and in short the parts of existence are infinite." "That is true." "Its parts are the most numerous of all." "Yes, they are the most numerous." "Well, is there any one of them which is a part of existence, but is no part?" "How could that be?" "But if there is, it must, I imagine, so long as it is, be some one thing; it cannot be nothing." "That is inevitable." "Then unity is an attribute of every part of existence and is not wanting to a smaller or larger or any other part." "True."

[144d] "Can the one be in many places at once and still be a whole? Consider that question." "I am considering and I see that it is impossible." "Then it is divided into parts, if it is not a whole; for it cannot be attached to all the parts of existence at once unless it is divided." "I agree." "And that which is divided into parts must certainly be as numerous as its parts." "It must." "Then what we said just now—that existence was divided into the greatest number of parts—was not true for it is not divided, you see, into any more parts than one,

[144e] but, as it seems, into the same number as one for existence is not wanting to the one, nor the one to existence, but being two they are equal throughout." "That is perfectly clear." "The one, then, split up by existence, is many and infinite in number." "Clearly." "Then not only the existent one is many, but the absolute one divided by existence, must

be many." "Certainly."

"And because the parts are parts of a whole, the one would be limited by the whole;

[145a] or are not the parts included by the whole?" "They must be so." "But surely that which includes is a limit." "Of course." "Then the existent one is, apparently, both one and many, a whole and parts, limited and of infinite number." "So it appears." "Then if limited it has also extremes ?" "Certainly." "Yes, and if it is a whole, will it not have a beginning, a middle, and an end? Or can there be any whole without these three? And if any one of these is wanting, will it still be a whole?" "It will not."

[145b] "Then the one, it appears, will have a beginning, a middle, and an end." "It will." "But surely the middle is equally distant from the extremes for otherwise it would not be a middle." "No." "And the one, apparently, being of such a nature, will partake of some shape, whether straight or round or a mixture of the two." "Yes, it will."

"This being the case, will not the one be in itself and in other?" "How is that?" "Each of the parts doubtless is in the whole and none is outside of the whole." "True." "And all the parts are included in the whole ?"

[145c] "Yes." "And surely the one is all its parts, neither more nor less than all." "Certainly." "But the whole is the one, is it not?" "Of course." "Then if all the parts are in the whole and all the parts are the one and the one is also the whole, and all the parts are included in the whole, the one will be included in the one, and thus the one will be in itself." "Evidently." "But the whole is not in the parts, neither in all of them nor in any.

[145d] For if it is in all, it must be in one, for if it were wanting in any one it could no longer be in all; for if this one is one of all, and the whole is not in this one, how can it still be in all?" "It cannot in any way." "Nor can it be in some of

the parts; for if the whole were in some parts, the greater would be in the less, which is impossible." "Yes, it is impossible." "But not being in one or several or all of the parts, it must be in something else or cease to be anywhere at all?" "It must." "And if it were nowhere, it would be nothing, but being a whole, since it is not in itself, it must be in something else, must it not?"

[145e] "Certainly." "Then the one, inasmuch as it is a whole, is in other and inasmuch as it is all its parts, it is in itself; and thus one must be both in itself and in other." "It must." "This being its nature, must not the one be both in motion and at rest?" "How is that?" "It is at rest, no doubt, if it is in itself; for being in one,

[146a] and not passing out from this, it is in the same, namely in itself." "It is." "But that which is always in the same, must always be at rest." "Certainly." "Well, then, must not, on the contrary, that which is always in other be never in the same, and being never in the same be not at rest, and being not at rest be in motion?" "True." "Then the one, being always in itself and in other, must always be in motion and at rest." "That is clear."

"And again, it must be the same with itself and other than itself,

[146b] and likewise the same with all other things and other than they, if what we have said is true." "How is that?" "Everything stands to everything in one of the following relations: it is either the same or other; or if neither the same or other, its relation is that of a part to a whole or of a whole to a part." "Obviously." "Now is the one a part of itself?" "By no means." "Then it cannot, by being a part in relation to itself, be a whole in relation to itself, as a part of itself." "No, that is impossible." "Nor can it be other than itself."

[146c] "Certainly not." "Then if it is neither other nor a part nor a whole in relation to itself, must it not therefore be

the same with itself?" "It must." "Well, must not that which is in another place than itself—the self being in the same place with itself—be other than itself, if it is to be in another place?" "I think so." "Now we saw that this was the case with one, for it was in itself and in other at the same time." "Yes, we saw that it was so." "Then by this reasoning the one appears to be other than itself."

[146d] "So it appears." "Well then, if a thing is other than something, will it not be other than that which is other than it?" "Certainly." "Are not all things which are not one, other than one, and the one other than the not one?" "Of course." "Then the one would be other than the others." "Yes, it is other." "Consider; are not the absolute same and the absolute other opposites of one another?" "Of course." "Then will the same ever be in the other, or the other in the same?" "No." "Then if the other can never be in the same, there is no existing thing

[146e] in which the other is during any time; for if it were in anything during any time whatsoever, the other would be in the same, would it not?" "Yes, it would." "But since the other is never in the same, it can never be in any existing thing." "True." "Then the other cannot be either in the not one or in the one." "No, it cannot." "Then not by reason of the other will the one be other than the not one or the not one other than the one." "No." "And surely they cannot by reason of themselves be other than one another, if they do not partake of the other."

[147a] "Of course not." "But if they are not other than one another either by reason of themselves or by reason of the other, will it not be quite impossible for them to be other than one another at all?" "Quite impossible." "But neither can the not one partake of the one; for in that case they would not be not one, but would be one." "True." "Nor can the not one be a number; for in that case, too, since they

would possess number, they would not be not one at all." "No, they would not." "Well, then, are the not one parts of the one?" "Or would the not one in that case also partake of the one?" "Yes, they would partake of it."

[147b] "If, then, in every way the one is one and the not one are not one, the one cannot be a part of the not one, nor a whole of which the not one are parts, nor are the not one parts of the one, nor a whole of which the one is a part." "No." "But we said that things which are neither parts nor wholes of one another, nor other than one another, are the same as one another." "Yes, we did." "Shall we say, then, that since the relations of the one and the not one are such as we have described, the two are the same as one another?" "Yes, let us say that." "The one, then, is, it appears, other than all other things and than itself, and is also the same as other things and as itself."

[147c] "That appears to be the result of our argument."

"Is it, then, also like and unlike itself and others?" "Perhaps." "At any rate, since it was found to be other than others, the others must also be other than it." "Of course." "Then it is other than the others just as the others are other than it, neither more nor less?" "Certainly." "And if neither more nor less, then in like degree?" "Yes." "In so far as it is so affected as to be other than the others and the others are affected in the same way in relation to the one, to that degree the one will be affected

[147d] in the same way as the others and the others in the same way as the one." "What do you mean?" "I will explain. You give a particular name to a thing?" "Yes." "Well, you can utter the same name once or more than once?" "Yes." "And do you name that to which the name belongs when you utter it once, but not when you utter it many times? Or must you always mean the same thing when you utter the same name, whether once or repeatedly?" "The

same thing, of course." "The word other is the name of something, is it not?" "Certainly."

[147e] "Then when you utter it, whether once or many times, you apply it to nothing else, and you name nothing else, than that of which it is the name." "Assuredly." "Now when we say that the others are other than the one, and the one is other than the others, though we use the word other twice, we do not for all that apply it to anything else, but we always apply it to that nature of which it is the name." "Certainly."

[148a] "In so far as the one is other than the others and the others are other than the one, the one and the others are not in different states, but in the same state; but whatever is in the same state is like, is it not?" "Yes." "Then in so far as the one is in the state of being other than the others, just so far everything is like all other things; for everything is other than all other things." "So it appears." "But the like is opposed to the unlike." "Yes." "And the other to the same." "That is also true." "But this, too, was shown, that the one is the same as the others."

[148b] "Yes, it was." "And being the same as the others is the opposite of being other than the others." "Certainly." "In so far as it was other it was shown to be like." "Yes." "Then in so far as it is the same it will be unlike, since it has a quality which is the opposite of the quality which makes it like, for the other made it like." "Yes." "Then the same will make it unlike; otherwise the same will not be the opposite of the other."

[148c] "So it appears." "Then the one will be both like and unlike the others, like in so far as it is other, unlike in so far as it is the same." "Yes, that sort of conclusion seems to be tenable." "But there is another besides." "What is it?" "In so far as it is in the same state, the one is not in another state, and not being in another state it is not unlike, and not

being unlike it is like but in so far as it is in another state, it is of another sort, and being of another sort it is unlike." "True." "Then the one, because it is the same as the others and because it is other than the others, for both these reasons or for either of them would be both like and unlike the others."

[148d] "Certainly." "And likewise, since it has been shown to be other than itself and the same as itself, the one will for both these reasons or for either of them be both like and unlike itself." "That is inevitable." "Now, then, consider the question whether the one touches or does not touch itself and other things." "I am considering." "The one was shown, I think, to be in the whole of itself." "Right." "And the one is also in other things?" "Yes." "Then by reason of being in the others

[148e] it would touch them, and by reason of being in itself it would be prevented from touching the others, but would touch itself, since it is in itself." "That is clear." "Thus the one would touch itself and the other things." "It would." "But how about this? Must not everything which is to touch anything be next to that which it is to touch, and occupy that position which, being next to that of the other, touches it?" "It must." "Then the one, if it is to touch itself, must lie next to itself and occupy the position next to that in which it is." "Yes, it must." 9

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1 See Diogenes Laertius, Lives of Eminent Philosophers

2 See Sextus Empiricus

3 See Eusebius, Preparation for the Gospel

4 See Heraclitus: Homeric Problems

5 See THE E AT DELPHI (DE E APUD DELPHOS)

6 See Refutation of All Heresies

7 See Ioannis Stobaei Anthologium; Volume 3

8 See Heraclitus (Stanford)

9 See Plato, Parmenides (137c)

Appendix Δ (delta) – Dates of Ancient Philosophers

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Note: Dates may vary depending on the source and may be incomplete.

Anaxagoras
fl. mid-5th cent. BC
Anaximander
6th cent. BC
Anaximenes
6th cent. BC
Antisthenes
ca.446-366 BC
Archytas
5th-4th cent. BC
Aristippus
ca. 435-356 BC
Aristotle
384-322 BC
Aristotle
384 - 322 BC
Cratylus
388 BC
Democritus
born ca. 460 BC
Diogenes of Apollonia
late 5th cent. BC
Diogenes of Sinope
ca. 404-323 BC
Empedocles
late 5th cent. BC

Gorgias
483-375 BC
Heraclitus
6th-5th cent. BC
Heraclitus
540 - 480 BC
Hesiod
7th cent. BC
Hippocrates
d. ca. 380 BC
Leucippus
5th cent. BC
Melissus of Samos
fl. ca. 440 BC
Parmenides
born ca. 510 BC 515 - 348 BC
Parmenides
late 6th century BC - mid 5th century BC
Philolaus of Croton
late 5th cent. BC
Plato
429-347 BC
Protagoras
d. ca. 420
Pythagoras
6th-5th cent. BC
Socrates
469–399 BC
Speusippus
ca. 410-338 BC
Thales
early 6th cent. BC
Theophrastus
372–288 BC

Xenocrates
395–313 BC
Xenophanes
6th-5th cent. BC
Xenophon
ca. 430-c.350 BC
Zeno of Elea
born ca. 490 BC

Appendix E (epsilon) – A Personal Note

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All of us hear and form judgements about ‘the way it is’ every day. These judgements tend to become habitual. When that happens, our judgements become territory to defend until ‘death do us part’. I have stated many ideas in this book which I am sure would provoke the ire of folks who know a lot more than me. For that I apologize and ask that you teach me. I have no fear of being wrong as I have been wrong far more than I have been right. But I have to say that the times I have been wrong are the times when I learned the most. I would rather have the struggle to learn and be wrong than the ease of being right. There is hope with being wrong. There is no hope in the perpetual defense of being right. The defense of correctness tends to be gamesmanship with the incessant battle to defend the virtues of one’s judgements over and against the other, the bad faith other which seems to me to only turn out to be yet again, the echo of Narcissus – the binary duality of the ‘not’ of me which is taken as the bad faith other. Gamesmanship hollows out one’s soul and over time turns one into a shell of a human being. I would rather have a healthy respect for my failures than an overestimation of my ‘truths’. With that in mind I want to add a few notions which I have no basis for believing, much less thinking so I just chalk it up to fanciful ideas that, for me at least have a hopeful impact.

When I was 19 years old, as is not uncommon with young guys, I had a reckless and near-death experience which altered the direction of my life. In my early sixties, I endured the pain of losing my most loved and beautiful twenty-year-old son on April 23, 2017, at midnight which I still endure to this day on a daily basis. In the darkness of this sorrow which nevertheless still holds the place for the love of my son Chris, I have reflected on my own near fatal

mistake at the age of 19 years old. In my reflections on the quantum wave function and Everett's many-worlds branching I have imagined that it is possible that I may have taken an ill-fated branch that fateful night when I was 19 years old resulting in tragic consequences. In that narrative could this have been a deliberate branch which I chose? Could my parents on that branch have lived their lives in the pain my son left me for the rest of my life? At times I have been angry about what Chris did. But what if I inflicted the same pain on my parents on a different branch which I have no access to? Maybe Chris went onto another branch where he lived and went on to have a happy, fulfilling life in which his mom and I were filled with what every parent desires for their children for the rest of our lives. A happy fulfilled life is what every parent wants their children to have. With a view to that, what would it mean for me to be angry with what he did? There is a thought which comes to mind. All our ire and judgements may find their way back implicating only ourselves. The adulteress was brought before Jesus and asked should she be stoned to death which religious laws at the time required (for women only) caught in adultery. He responded, "He who is without sin, cast the first stone." John 8:7. We all need to remember that in all our judgements and anger of the other. We may find that the face of the other all along we derided, scoffed, or were angry with may well have been our own narcissistic echo, our own narcissistic face. There is another biblical saying,

> Judge not, that you be not judged. For with what judgment you judge, you will be judged. And with the measure you use, it will be measured again for you. And why do you see the speck that is in your brother's eye, but do not consider the plank that is in your own eye? Or how will you say to your brother, 'Let me pull the speck out of your eye,' when a log is in your own eye?[1]

Realistically, we all cannot help but make value judgements.

These kinds of judgements fall from our personal and historic orientations. However, we should be fully aware that we may find one day that the other we judged, we were angry with, points directly at us and not the other we imagined. I think that the idea that the wave function branching means we no longer have access to all the other branches is, at the least, an interesting and compelling vehicle for serious self-reflection.

Here is another idea which is certainly fanciful without a shred of evidence but what if…? We have all heard about people's near-death experiences where they are in a tunnel and move towards a light at the other end. Some say their loved ones who have passed on are waiting in that light at the end of the tunnel. I know it is a crazy idea, but could that tunnel be an entangled wormhole? Ok, ha, ha - I laugh too but let's pursue this foolishness. Let's suppose that, as entangled systems ourselves, we are incessantly entangling and being entangled—a continuous loop driven by the 'spookiness' of the observer effect. And not just other people also with Gaia (referenced in the section entitled "Philosophical Implications of Quantum Computing and Chaos") or what I have called *phusis*. Don't ask me to explain this or justify this because I cannot but, for me personally, I find some hope in the idea that there may be much more to the story of life than we can possibly imagine. One thing I do know is in life we reap what we sow - karma. If our life practice culminates (*telos*) in the encasement, the tomb of our narcissistic echoes of ourselves then the only hope we have is in death, our own death, to end the misery of our absolute 'one-without-an-other' life…but I would not count on that if I were you. We had no choice about being born, gradually more or less emerging from the chaos of a 'wave function' perhaps which had not yet fallen into 'sense' much less commonsense. All through life we blank-out (some more than others myself included here), daze, mentally fog – just call it intermittent degrees of wave function superposition arousing itself into state reduction, branching, etc. It has occurred to me this can become more frequent with aging (as I keep forgetting what I was

supposed to remember). If all this is so, certainly old age and death would be the entry back into the chaos of the wave function. Who is to say we could yet wake once again rise from that slumber? And Nietzsche's adage of eternal return to exactly the same life we had may have been more of the voice of classicism (finite space and infinite time will eventually repeat itself exactly) than the spooky observer effect. And if nothing after death as modernists maintain it does not bother me in the least.

There is nothing to fear about death as nothingness. I think when we are younger, we have fears about death, anxiety about nothingness, but I think age can be a valuable lesson in that regard. Hope is for this life. Life will present all of us with heartache if we are doing something right. Getting numb, feeling nothing, is nothingness in this life. Nothing can be done about that if choice does not override passiveness. Caring and loving deeply is painful. Young folks have expectations about love which is probably appropriate for their age (speaking as an ex-young person). But gaining wisdom about love means feelings of loss and pain are not to be shunned but are profound places of the other who may no longer present. They are the traces of the other in me - still. They are life throbbing in and through the tree of life. They show that the tree is still green, and that life has conquered the vacuity and rot of death. Those that are rooted in their own echo, their own vacuousness and numbness are shells of a rotten tree, eaten by their own disease. This is when hope has vanished into nothingness before death. This is dying nothingness which can only see bleakness and despair in every future. We must learn the wisdom of contentedness for this life only, to live and love fully, to believe and hope for life itself. So, even if there is nothing after death there was something in life. The rest does not concern us. And, if we do blink back from superposition after death, we will blink back full and ready for whatever. On the other hand, the resignation, despair, and emptiness of one without the other, without care and responsibility for the other, without wonder beauty and awe in all its fullness and

pain is not a good way to welcome a new sapling into the tree of life. I do not consider myself a Christian, but I am reminded of the odd reference in Genesis, "*Now, lest he [we] reach out his [our] hand and take also of the tree of life and eat, and live forever—*".

I have no allusions about what some think of as 'realism', common sense, the 'way it is'. I think I have made clear why I think we can go no further than 'narrative' both personally, collectively, and historically. This becomes difficult when we think of evil, of atrocities like Hitler and overtly horrific evil acts. But the thing I remember is that in my way of thinking, my narrative, there is no justification for the Hitler's of history. In my estimation, they are the final gaze of Orpheus which can no longer see Eurydice, the other, but can only perpetually see their own narcissistic face departing into the underworld of one without another, where the observer effect has become only of oneself – devoid of ethics, without any other to oneself. My idea of **Hell** is simply one without another. It may be my narrative, but my narrative is no less true than the modernist narrative of empirical facts which are absolute in a mechanistic 'reality'. And by the way, that particular metaphysic has never been able to claim any higher ground concerning the evils of humanity as well. On the contrary, it certainly has a history of ennobling the brutal tyrants of history – Ayn Rand comes to mind. And also, with Donald Trump this idea of '*nonsensical but persuasive rhetoric transformed into the rhetorician's own personal glory and transformed into might makes right*' seems to be yet another example of how 'realism' has come to play as 'empirical facts'. In my humble opinion capitalism without any rules will inevitably engender human epitomes unexamined narcissistic rage.

I am sure there are those that will think I am a raving communist. I am not. I am closer to what Europeans call a market democratic socialist. I love and value democracy and would not want to live under any political system. Republicans have been crying wolf about socialism from the early 20th century unto the

present day and Democrats have denied it. Don't believe me? See my post with quotes from Howard Taft as far back as 1908, The American Liberty League going back to 1933, Father Charles Coughlin, Harry Truman, Joe McCarthy, Barry Goldwater, John McCain, Dwight Eisenhower, Ronald Reagan, and Newt Gingrich. [2] Even today the far right is threatening us with *becoming* socialists. This is all fear tactics because even by the history of the far right's own admissions, we are already a mix of socialism and capitalism which is the definition of market based democratic socialism in much of Europe and in the United States is called a social democracy. [3]

> Markets generate problems of their own (especially when they involve monopolies, negative externalities, and asymmetric information). But if regulations are introduced to counter these "market failures", markets can be the best feasible mechanism for generating matches between demand and supply in large, complex societies (as higher prices signal high demand, with supply rushing to cover it, while lower prices signal low demand, leading supply to concentrate on other products). Market socialism affirms the traditional socialist desideratum of preventing a division of society between a class of capitalists who do not need to work to make a living and a class of laborers having to work for them, but it retains from capitalism the utilization of markets to guide production. [4]

By the textbook definition of socialism, we have been a version of a socialist state called market socialism since at least the beginnings of labor unions, Social Security, Medicare, Medicaid, and Welfare Programs.

> Social democracy has a strong, long-standing connection with trade unions and the broader labour movement. It is

> supportive of measures to foster greater democratic decision-making in the economic sphere, including co-determination, collective bargaining rights for workers, and expanding ownership to employees and other stakeholders.
>
> Socialism is nothing other than what has evolved in this country for over a hundred years. The Republicans are correct in telling us this. They just need to lose the sneer and quit trying to make it an all or nothing, capitalism or socialism, apocalyptic event. The rhetoric is too old to get a rise out of all but the most ardent devotees of their faith. Problem solving is quite different from power acquisition. We need to decide if we are going to solve problems or let the free acquirers of power decide for us. [5]

We have partial public ownership we call stocks. We have economic interventionism putting checks on monopolies. For many years we have openly promoted social equality. Of course, the new and boringly old fear tactics of extremists have found yet another rhetorical, same ol' tactical tagline, "Woke".

> Social democracy maintains a commitment to representative and participatory democracy. Common aims include curbing inequality, eliminating the oppression of underprivileged groups, eradicating poverty, and upholding universally accessible public services such as child care, education, elderly care, health care, and workers' compensation. Economically, it supports income redistribution [progressive taxation] and regulating the economy in the public interest. [6]

There has never been a pure capitalist state in which only the 'free' market decides because in its pure form it reverts into a kleptocracy. Communism was a complete and total horror and human disaster. Capitalism has made a mantra of marketeer's, AKA branding guru's, motto that 'perception is reality'. The insidious and

easily escapable fact of that truism is that perception is moldable, tailorable, customizable to ego, whim, desire, and unabashed narcissism where 'reality' is merely transactional. For the record I am not a new-ager or a communist, but marketing is a science which has been proven to work in shaping everything from consumer purchases, expectations, and demands to political persuasions and basic philosophical assumptions - and that is an empirical fact. The advent of smart phones and technology which consumes much time and attention from users puts a constant stream of commercials into a worldwide audience every day. This was already a bonanza for marketeers. But now with artificial intelligence the marketing avenues can be customized for each individual consumer as if their very best friend was conversing with them. Once quantum computing gets married to artificial intelligence, the potency of marketing will be unrivaled. Quantum intelligence can interact with you like your best friend or God or whatever dearly held personal values you might have. For a marketeer it will be like Morpheus in the movie "The Matrix" where he/she/it (or pick your pronoun) can lure you back into the Matrix consuming you as their energy source (or what we now think of as money). Ok, let's not get paranoid here. 😉

Can consumers be critical thinkers and make their own choices? Ideally, that would be true. But marketing science has shown for many decades that strong and impulsive emotions coupled with social network theory sells products. Marketing can sell anything, not just products. It can sell philosophies, ideologies, and the most bizarre cultish ideas, all in the service of its benefactors. Critical thinking is the only solution to this looming dilemma. But education and universities are not immune from the mediocrity of laissez-faire, 'letting the market decide'. And the market has all the most powerful tools in human history to actually let the marketeers decide not the consumers. Again, I am not a communist. I believe capitalism, when it works and is well regulated to avoid hazards like destroying the environment, protecting consumers from fraud,

etc., is a positive vehicle for wealth distribution and addressing fundamental issues of human suffering. Additionally, for the 'free' market to work well it cannot be rigged by the golden rule – those who have the money make the rules. What I am about to write is not meant to be universal as it is only my anecdotal experience, but I personally think it applies more than many folks are aware of.

I have worked in small, medium, and multinational companies and depending on the size of the company the guys at the top are all happy to fund candidates and lobbyists to get rid of regulations they do not like and create regulations they do like. They are highly successful 'gerrymandering' so to speak the 'rules' of the not so 'free' market to accommodate their agendas. And if that does not work the good 'ol boys' network is always the backup. The executives at the multinational company I worked for were more of a social country club of prospective and strategic partners, subsidiaries, and even competitors than anything else. With regard to consumers and employees, I remember a senior vice president at the multinational company I worked for going on and on during social occasions about tribalism. He saw his job as weaving a tribal myth, a tale, an oracular edict (his words not mine) that would bind the clan to a sacred duty – to get him richer!

As for the science of marketing, ever increasing personal electronics and the future of quantum intelligence will mean there is no amount of regulation which can forestall its eventual domination. The only hope against human automatons is critical thinking skills enhanced by higher quality and free education at all levels. The ability to see through the oncoming onslaught of perception as reality using social network theory and sensory marketing is the only resistance against a brave new world of Orwell's book "1984". The science of marketing has a term called sensory marketing which is an advertising tactic that appeals to one or more of the five human senses of sight, hearing, smell, taste, and touch to create an emotional association with a specific product or brand. Sensory marketing assumes that people, as consumers, will

act according to their emotional impulses more than to their objective reasoning. In this way, an effective sensory marketing effort can result in consumers choosing to buy a certain product, rather than an equal but less expensive alternative. And this is not just for product consumers anymore. [7]

The science of marketing is real and proven, and it is not just for consumer products anymore. It can totally reshape values, ideologies, religious orientations, in a way that will make Charles Manson, David Koresh, Jim Jones, and Adolf Hitler look like Sunday School teachers. According to a recent article in the Journal of Consumer Research, consumption ideology is defined as "ideas and ideals that are related to consumerism and manifested in consumer behavior". [8] Another article from the American Marketing Association suggests that incorporating consumers' political orientation into companies' segmentation and marketing strategies can help companies anticipate and manage consumers' and brands' political activism as well as anticipate and leverage ideological differences in consumption across non-political domains. [9] Despite what we are hearing from high tech CEOs about needing more regulation for artificial intelligence, ultimately the movement towards quantum intelligence will not be deterred by regulations and public safety laws. The days when external social safeguards were effective are coming to an end. These technologies coupled with marketing science will put more and more demand on educated consumers. Soft pedaling this threat can only have apocalyptic consequences.

Technology will increasingly and inevitably reduce jobs which do not require more advanced training. Without serious and concerted efforts to educate and train people for many diverse occupations in science, technologies, and humanities we will see more and more social upheaval which may well end in Homo sapiens species extinction. I know the study of humanities has been banished from the land of the living, but it is actually a historic record of the land of the living which is invaluable for thinking

critically. Humans are standing on a precarious abyss with astounding achievements unparalleled in our history. However, just like every evolutionary advantage, there are also built-in disadvantages which eventually can cause adaptation to fall behind. Quantum intelligence as Yuval Harari writes about will be a new and powerful evolutionary species with incredible adaptive advantages over Homo Sapiens. Quantum intelligence is incredible because its evolution did not come from typical biological adaptation but from the promise of intelligence which was always built into *phusis*. It holds a massive promise for Homo Sapiens but just like the atomic bomb can become an extinction threat from authoritarians who have the means and the desire to usurp their violent agendas on the world. I am not convinced that we as humans can and will have the wherewithal to work with *phusis* ethically and responsibly towards the radical exteriorities we face. What we face or run from is responsibility for the other.

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1 See Mathew 7:1-4

2 See Clashing Histories – Right Fright in the Light

3 See Social democracy - Wikipedia

4 See Socialism (Stanford Encyclopedia of Philosophy)

5 See Clashing Histories – Right Fright in the Light

6 See Social democracy - Wikipedia

7 See An Introduction to Sensory Marketing

And The Science of Emotion in Marketing: How Our Brains Decide What to Share and Whom to Trust

And Emotional Appeals in Advertising

And Sensory Marketing: Straight to the Emotions

8 See Consumption Ideology

9 See How Politics Shapes Consumption Behavior

Further Reading

Further Reading

Here are good reference articles in Quanta magazine for some of the basic physics notions discussed throughout this post:

How Quantum Pairs Stitch Spacetime | Quanta Magazine

Interactive: What Is Space? | Quanta Magazine.

Here are several videos oriented to the physics novice that will also provide an excellent background for the physics material I plan to cover:

Leonard Susskind | "ER = EPR" or "What's Behind the Horizons of Blackholes?" - 1 of 2 (video)

Leonard Susskind | "ER = EPR" or "What's Behind the Horizons of Blackholes?" - 2 of 2 (video)

Lecture 1 | Quantum Entanglements, Part 1 (Stanford) (video)

Lecture 2 | Quantum Entanglements, Part 1 (Stanford) (video)

Here are more reference articles which I found very interesting:

Physics of the Universe | Kavli Institute for Particle Astrophysics and Cosmology (KIPAC) (stanford.edu)

Loeb, AVI. December 12, 2020. "Endless Creation Out of Nothing. Scientific American (online)

Kane, Gordon. October 9, 2006. "Are virtual particles really constantly popping in and out of existence? Or are they merely a mathematical bookkeeping device for quantum mechanics?". Scientific American (online)

Wave Function Collapse

Spontaneous Symmetry Breaking

Symmetry Breaking

Max Born

Wave Function

Schrödinger equation

Delta Potential

Introduction to Quantum Mechanics

Erwin Schrödinger

What Is Life?

Non-Relativistic Quantum Mechanics Lecture Notes

Quantum State

Mass

Poincare Group

Relativistic Mass (ucr.edu)

Non-relativistic spacetime

About Non-relativistic Quantum Mechanics and Electromagnetism

A non-relativistic theory of quantum mechanics and gravity with local modulus symmetry (pdf)

The Bronstein hypercube of Quantum Gravity

Relativistic Quantum Mechanics

Is Zero Point Energy Real? (pdf)

Virtual Particles: What are they?

Physics Questions People Ask Fermilab

Virtual particle

Copenhagen Interpretation of Quantum Mechanics

Copenhagen interpretation

SAGP SSIPS Abstracts 2015

"The Unmoved-Mover" in Aristotle's Metaphysics

Metaphysics

The Philosophical Sense of Transcendence: Levinas and Plato on Loving Beyond Being

Quantum Entanglement

Refrigeration by Quantum Measurements

Using quantum measurements to fuel a cooling engine

Entanglement Made Simple

What is quantum entanglement? All about this 'spooky' quirk of physics

Your Simple (Yes, Simple) Guide to Quantum Entanglement

How is quantum entanglement related to decoherence?

Information Philosopher - Philosophy
Quantum mysteries dissolve if possibilities are realities | Science News
Emmanuel Levinas

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Comments on the End Notes

There are over 2,000 references in this book. Most of the references are not referencing the quotes I used in the book. I wanted to give the reader extra reading and research material on specific points I was discussing. I think it is important for the reader to have additional material to substantiate and expand on specific topics I discussed. I think of this as an important service to the reader. Most books strictly reference quotes and may provide additional reading material at the end (which I also have done). By providing many more references than needed, I also wanted to reassure myself and demonstrate that I was not too far off the beaten path.

In terms of physics, I have included theoretical material in this book. Part of the reason I did this was because many of the findings in quantum physics are novel. This is because in many cases quantum physics has not been around long enough for theory to find common acceptance. With all the capital being spent on quantum intelligence, findings in quantum physics are almost daily coming to the surface of its vast uncharted, I think un-chartable, terrain. When I did employ theoretical results, I made every effort to remain as close as I could to experimental evidence. However, in some cases I did explore a bit of future directions as well.

With regard to philosophy, I wanted to at least look for common consensus among scholars. By its nature, philosophy is more prone to interpretation including my own philosophical musings. I do not claim to be correct in my conclusions as there are always legitimate arguments which counter virtually anyone's opinion. However, I do not think of various interpretations as a weakness but a strength. Physics as well makes interpretations. I illustrated this clearly in the section entitled, "Interpretations of the Quantum Wave Function". Both science and philosophy offer room for interpretation. Both fields comingle in some incredible and beautiful ways. The depth

and directions of interpretations were a major effort I wanted to illustrate in this book.

As far as specific references are concerned, I found ChatGPT and Gemini to be a reliable tool for digging up relevant references to my current discussion. In the past it would have taken me days and weeks to dig out relevant references. However, when I asked ChatGPT or Gemini for references I did not just rely on the references it gave me. If I had access to the reference material, I would verify that the topic pertained to the point I was making. If I did not have access, as in subscription journals, I would read the abstract to ensure that it pertained to the topic I was discussing. Otherwise, I did not include the reference. I also found AI to be useful finding grammatical errors and also suggesting other ways to modify my writing that seemed clearer to me than my previous versions. I found the interaction with AI was useful but AI was also prone to introducing meanings that I did not intend. So that limited my ability to use AI in this fashion. I did not rely on AI too much for the main body of text except in the section entitled, “Entangling Observations About ChatGPT 4 and Us”. In that section I wanted to illustrate that ChatGPT was not always correct and even contradicted itself at times. However, we need to understand that this is not the fault of ChatGPT or Gemini. This is more precisely a virtue of intelligence which exemplifies its inability to complete itself just as we are never able to complete ourselves. If we could be complete in ourselves there would be no other. Without the other there would not even be a possibility of a ‘me’. And what would knowledge *be* without the incompleteness of a ‘me’ in the face of an other?

Even so, intelligence is not dogma but is capable of simultaneously holding multiple ideas, even contradictory ideas, simultaneously. Think of complementarity and the wavicle. Quantum physics is a beautiful illustration of how classicism to some degree lost its way in simply assuming that non-contradiction was universal truth. This critique of dominant strands in classicism

was a major tenet I tried to illustrate in this book. Classicism was not so much wrong in assuming its dominant classical schemes as it erred in imagining there was no excess to them, e.g. rationalism, positivism, etc.. While quantum physics explores many avenues of how complementarity arises, complementarity is not reductively about binary dualities. This would simply reiterate a dominant theme in classicism. Quantum physics can hold, at once, contradictory dualities and multiplicities but always as excess. Excess cannot be accounted for by such simplistic determinations as binary dualisms and contradictions. Quantum physics exceeds the asymptotic determinations of classical physics without lapsing into some sort of mystic proclamation arising out of language and history.

While I have shown there is ample room for intuitive and historic interpretations of quantum physics, quantum physics exceeds the classical notions of real and ideal, self and other, body and mind, science as truth and dogma as opinion. To illustrate this, I need only mention the spooky observer effect which is not subjective or objective – exceeding both. I have tried to bring out interesting and frankly startling intersections with Levinas and quantum physics.

What is more, Levinas brings us an infinite distance further than quantum physics can, placing us at a precipice where responsibility and ethics to the other are at the zenith of human endeavors – to the other who faces me, radically exterior to all my reductive, narcissistic determinative echoes. Quantum physics is the place where all classical determinations must give way to incredible and wonderful excess, I have termed this excess ‘chaos’. Infinitely more than chaos, Levinas finds the self, me, in retreat from radical exteriority, spun and held responsible to, radical externality. The other is precipice, “a past not my past”,

> “The past of the other, a past that is not my past, but which affects me as though it were my own, is the very essence of

responsibility." -Emmanuel Levinas, trans. Alphonso Lingis (The Hague: Martinus Nijhoff, 1981), 115–118.

End Notes

1. PHUSIS: TOWARDS RADICAL EXTERIORITY AS PHYSICS

i See Hugh Everett III

Hugh Everett III, November 11, 1930 – July 19, 1982) was an American physicist who first proposed the many-worlds interpretation (MWI) of quantum physics, which he termed his "relative state" formulation. In contrast to the then-dominant quantum physics, the MWI posits that the wave function never collapses and that all possibilities of a quantum superposition are objectively real.

Discouraged by the scorn of other physicists for MWI, Everett ended his physics career after completing his PhD. Afterwards, he developed the use of generalized Lagrange multipliers for operations research and applied this commercially as a defense analyst and a consultant. In poor health later in life, he died at the age of 51 in 1982. He is the father of musician Mark Oliver Everett.

Although largely disregarded until near the end of Everett's lifetime, the MWI [many worlds' interpretation] received more credibility with the discovery of quantum decoherence in the 1970s and has received increased attention in recent decades, becoming one of the mainstream interpretations of quantum mechanics alongside Copenhagen, pilot wave theories, and consistent histories. Hugh Everett III

Also see MIT's biography of Everett here: BIOGRAPHICAL SKETCH of HUGH EVERETT, III

Also, I found this spinoff from one of Everett's ideas very interesting,

Quantum suicide is a thought experiment in quantum mechanics and the philosophy of physics. Purportedly, it can falsify any interpretation of quantum mechanics other than the Everett many-worlds interpretation by means of a variation of the Schrödinger's cat thought experiment, from the cat's point of view. Quantum immortality refers to the subjective experience of surviving quantum suicide. This concept is sometimes conjectured to be applicable to real-world causes of death as well.

As a thought experiment, quantum suicide is an intellectual exercise in

which an abstract setup is followed through to its logical consequences merely to prove a theoretical point. Virtually all physicists and philosophers of science who have described it, especially in popularized treatments, underscore that it relies on contrived, idealized circumstances that may be impossible or exceedingly difficult to realize in real life, and that its theoretical premises are controversial even among supporters of the many-worlds interpretation. Thus, as cosmologist Anthony Aguirre warns, "[...] it would be foolish (and selfish) in the extreme to let this possibility guide one's actions in any life-and-death question." Quantum suicide and immortality

Interesting enough, in Plato's Republic he recounts the ancient Greek myth of Er. However, instead of using the Greek word myth, Plato uses the Greek word *logos* which is discussed later in this book but for now I will simply define it as word, speech, or account. The tale is about what happens after death. In earlier Greek mythology *Lethe* is one of the five rivers of the underworld. *Lethe* means oblivion, forgetfulness, or concealment. The other four rivers in the underworld were *Acheron* meaning river of sorrow, *Cocytus* meaning river of lamentation, *Phlegethon* meaning river of fire, and *Styx* was the river that separated the earth from the underworld. In Plato's version Socrates explains to Glaucon, Plato's older brother, that after death every soul was required to choose their next life. Many choose badly for fame, glory, riches, and pride. After they choose, they had to drink from the grail of forgetfulness (*Lethe*) upon which they would be reborn into whatever life they choose. Those who choose foolishly found out too late that they had to suffer horrible consequences like eating their own children. However, Er was required to return to the land of mortals by the gods to report what he had learned about what happened after death. This is how we became aware of what happens after death. See also,

Lethe

Elysion

Myth of Er

I find all this a bit intriguing since I can see how in Everett's idea this could fit in with information updates which is what the quantum wave function is all about. Hugh Everett was discredited during his life and died at the age of 51 only to posthumously be recognized for important contributions to 20th century physics.

ii See What does 'nature' mean?

Also, *naturalis*

nātūrālis (third-declension two-termination adjective)

natural by birth, legitimate

of or pertaining to nature

of or pertaining to something's nature or qualities

real, not fictitious

Also, nature

late 13c., "*restorative powers of the body, bodily processes; powers of growth*", from Old French nature "*nature, being, principle of life; character, essence*", from **Latin natura "*course of things; natural character, constitution, quality; the universe*", literally "*birth*", from *natus* "*born,*" past participle of *nasci* "*to be born*", from PIE root **gene-* "*give birth, beget.*"

By mid-14c. as "*the forces or processes of the material world; that which produces living things and maintains order.*" From late 14c. as "*creation, the universe*", also "*heredity, birth, hereditary circumstance; essential qualities, inherent constitution, innate disposition*" (as in human nature); also "*nature personified, Mother Nature.*" Nature and nurture have been paired and contrasted since Shakespeare's "Tempest."

Also, more on *naturalis*

Latin > English

nātūrālis N M :: physical/natural scientist; physicist; natural philosopher

nātūrālis, *naturale* ADJ :: natural, normal, typical, characteristic; innate, inherent; physical (science)

nātūrālis, *naturale* ADJ :: natural; (not adoptive, parents); (parts of body/ genitals, excretory outlets)

Latin > English (Lewis & Short)

nātūrālis: e, adj. natura,

I natural, i. e.,

I By birth, one's own: *nātūrālis* pater, opp. to adoptive father, Cic. Phil. 3, 6, 15: *in adoptionem dato redire in familiam liceat, si pater naturalis sine liberis decesserit*, Quint. 3, 6, 96: filius (= κατὰ φύσιν υἱός), Liv. 42, 52: *Pauli nepos*, id. 44, 44; Suet. Tib. 52; Gai. Inst. 2, 137; 3, 31: *qui in avi sui naturalis potestate est*, Dig. 37, 8, 1, § 2; also, natural, illegitimate (= *nothus*), Dig. 40, 5, 40; 36, 1, 80, § 2; Aug. Conf. 6, 12; Inscr. Grut. 945, 3. —

II Of or belonging to the nature of things, produced by or agreeable to nature, natural: *naturale est alicui*, it is natural to one, it is his innate quality, Plin. 11, 37. 54, § 144: *historia*, id. praef. § 1: *motus naturalis*, Cic. Fin. 1, 6, 19: *societas*, id. Off. 1, 16, 50: lex, id. N. D. 1, 14, 36: *notio*

naturalis atque insita in animis nostris, id. Fin. 1, 9, 31: *naturalis, non fucatus nitor*, id. Brut. 9, 36: *bonum*, id. Cael. 5, 11: dies, a natural day, i. e. from sunrise to sunset, opp. to the dies *civilis*, Censor. *de Die* Nat. 23; v. *civilis: mors*, a natural, not a violent death, Plin. 7, 53, 54, § 180 (for the class. *mors necessaria*, Cic. Mil. 7, 16): *naturales exitus*, the anus, Col. 6, 30, 8: *naturalia* desideria, the *sexua*l impulse, id. 6, 24, 2; 6, 27, 7: *loca naturalia*, the sexual parts of men and animals, Cels. 1, p. 11 Milligan.—As subst.: *nātūrāle*, is, n., the private parts: *sanguinis pars per naturale descendit*, Cels. 5, 26, 13; 7, 26, 1 al.—More freq. plur., *nātūrālĭa, ĭum*, n., in same sense, Cels. 4, 21 init.; 5, 20, 4; 6, 18, 2 al.; Col. 6, 27, 10; Just. 1, 4, 2.—

III Of or concerning nature, natural: naturales quaestiones, Cic. Part. 18, 64: *historia*, Plin. H. N. praef. § 1: *philosophia*, Isid. Orig. 2, 24, 12.—

Opp. to fictitious, natural, real: *philosophi duos Joves fecerunt, unum naturalem, alterum fabulosum*, Lact. 1, 11. —Hence, adv.: *nātūrālĭter*, naturally, conformably to nature, by nature: *nec vero umquam animus hominis naturaliter divinat*, Cic. Div. 1, 50, 113: *alacritas naturaliter innata*, Caes. B. C. 3, 92: *inter naturaliter dissimillimos*, Vell. 2, 60, 5; Plin. 11, 37, 47, § 130: *profluere (urinam)*, Cels. 7, 26, 1; Hirt. B. Alex. 8: *est aliquid in omni materiā naturaliter primum*, Quint. 3, 8, 6.

Also, origin

c. 1400, "ancestry, race," from Latin *originem* (nominative origo) "a rise, commencement, beginning, source; descent, lineage, birth," from stem of *oriri* "arise, rise, get up; appear above the horizon, become visible; be born, be descended, receive life;" figuratively "come forth, take origin, proceed, start" (of rivers, rumors, etc.), from PIE **heri-* "to rise" (source also of Hittite *arai-* "to arise, lift, raise," Sanskrit *iyarti* "to set in motion, move," *Armenian y-arnem* "to rise"). Meaning "beginning of existence" is from 1560s; sense of "that from which something derives its being or nature" is from c. 1600.

2. PHUSIS: TOWARDS RADICAL EXTERIORITY AS PHILOSOPHY

i Plato conceived of the self as a knower. His concept of the self is intricately intertwined with the nature of the rational soul, which he regarded as the highest form of cognition. Plato believed that the essence of a person lies in the psyche (Ancient Greek: ψῡχή), which he considered to be the incorporeal, eternal occupant of an individual's being. This rational soul is the seat of knowledge, and thus, the concepts of the self and knowledge are closely linked in Plato's philosophy. Plato's notion of the

true self emerges within the context of knowledge. According to Plato, we acquire our true self when we activate our latent knowledge of the Forms. The Forms (or Ideas) represent the ideal, unchanging, and eternal concepts that exist beyond the physical world. Activating this knowledge involves recognizing and understanding these Forms, which leads to self-discovery. Plato's view of the self transcends mere physical existence. The soul, as the real self, persists continuously from the earliest stages of life (from zygote or infancy) and remains unchanged by basic building materials. The Ship of Theseus is a thought experiment about whether an object is the same object after having had all of its original components replaced. Plato's perspective solves the Ship of Theseus dilemma. as the soul provides permanence even amidst bodily changes. Plato's concept of the self extends beyond earthly life. The soul, being eternal, persists into the afterlife, carrying with it the accumulated knowledge and experiences. Plato's idea of the self centers on the rational soul, knowledge, and the activation of latent wisdom. From Plato's cave analogy, most people see dimly their relationship to the Forms. However, even in this the Forms or essence, has a potential shadowy bridge to humankind. In Plato's view humans reflect reality imperfectly.

See Plato's Concept of the Self

And Plato's theory of soul

And Plato and the Divided Self

And 6.2 Self and Identity

ii Aristotle believed that the self, or the human person, is a composite entity consisting of both body and soul. Philosophers call this hylomorphism (from Greek *hylē*, "matter"; *morphē*, "form"). Aristotle considered the soul as the essential form of a living being. Hylomorphism conceives every physical entity or being as a compound of primary matter (potency) and immaterial, substantial form (act), with the generic form as immanently real within the individual. According to Aristotle every natural body consists of two intrinsic principles: one potential, namely, primary matter, and one actual, namely, substantial form. Aristotle based

his argument chiefly on the dynamic analysis of "*becoming*," or substantial change. If a being changes into another being, something permanent must exist that is common to the two terms; otherwise, there would be no transformation but merely a succession by the annihilation of the first term and the creation of the second. This permanent and common something cannot itself be strictly a being because a being already is and does not become, and because a being "*in act*" cannot be an intrinsic part of a being possessing a unity of its own; it must therefore be a being "*in potency*", a

potential principle, passive and indeterminate. At the same time, in the two terms of the change, there must also be an actual, active, determining principle. The potential principle is matter, the actual principle, form. This doctrine was central to Aristotle's philosophy of nature and has been variously interpreted by Greek and Arab commentators of Aristotle and by the Scholastic philosophers. According to Aristotle, the soul serves as the "*form*" of the human body. In other words, the soul gives structure and purpose to the physical body. This interconnectedness between body and soul implies that they are inseparable. Aristotle considered the soul as the essential form of a living being. While he acknowledged that the soul does not exist independently of the body, he distinguished different aspects of the soul. Aristotle believed that the intellect (or reason) is immortal and perpetual. It constitutes the higher part of the soul and is separable from the body. Aristotle's views diverged from those of Plato. Plato emphasized that the true self of human beings is their reason or intellect, which exists independently of the body. In contrast, Aristotle maintained that the soul's functions are intricately tied to the body's organization. In this sense Aristotle was more like a phenomenologist. For Aristotle the soul was defined by its actual manifestations. Aristotle's philosophy of self underscores the integrated unity of body and soul, with the soul acting as the formative principle that animates and directs human life.

See Aristotle's Concept of the Self

And Aristotle on the Individuality of Self

And Philosophy of self

And Hylomorphism (Wikipedia)

And Hylomorphism (Britannica)

And Hylomorphism (New World Encyclopedia)

iii Descartes believed that a human person consists of two distinct parts. The physical aspect of a person was the material body. The non-material part was the mind or soul. The thinking, conscious entity that transcends the physical world. Descartes posited a radical separation between the mind and the body. The thinking self (or soul) is nonmaterial, immortal, and conscious. It exists independently of the physical laws governing the universe. Descartes advocated for systematic doubt as a means to achieve clear and well-reasoned conclusions. By questioning everything accepted without scrutiny, individuals can develop beliefs that are genuinely their own. Descartes's concept of the self centers around the idea of a dual existence: a material body and an immaterial mind or soul. For Descartes, everything could be doubted except thinking. To doubt thinking would

require thinking. Therefore, Descartes tells us – I think therefore I am (*cogito, ergo sum*). From thinking, Descartes argues that our innate idea of God is of a perfect being. Existence is a form of perfection. Therefore, God must exist. The self is mind embedded in body, substance. Descartes is known for his mind/body dualism called the thinking thing. For Descartes, the soul (thinking) is immortal.

iv Leibniz rejected Cartesian doctrines that all mental states are conscious and that non-human animals lack souls or sensation. He believed that even non-rational animals possess souls and feelings, prompting him to reflect on the mental capacities distinguishing humans from lower animals. Leibniz proposed that perception, rather than consciousness (as Cartesians assumed), is the distinguishing feature of mentality. Rational souls have elevated types of perceptions, including self-consciousness and abstract thought. Human minds surpass animal souls due to their capacity for more elevated types of perceptions and appetitions (mental tendencies). Rational souls exhibit reasoning and the tendency to act according to overall judgments. Leibniz's thought experiment involving a mill argues that material things (such as machines or brains) cannot genuinely have mental states. Only immaterial entities (soul-like) can think or perceive. Thus, constructing a truly thinking computer is impossible. Leibniz's doctrine denies genuine interaction between body and soul. Instead, he posits that God created souls and bodies to naturally correspond without divine intervention. Leibniz's ideas about the self encompassed perception, elevated mental capacities, and the immaterial nature of thinking entities. For Leibniz, the self is monad, absolutely self-contained. There is no exteriority to the self.

See Gottfried Leibniz: Philosophy of Mind

And Self and Identity

And 10 Leibniz: Innate Ideas, Reflection, and Self-Knowledge

Leibniz writes, "*There is no way of explaining how a monad can be altered or changed internally by some other creature, since one cannot transpose anything in it, nor can one conceive of any internal motion that can be excited, directed, augmented, or diminished within it, as can be done in composites, where there can be change among the parts. The monads have no windows through which something can enter or leave. Accidents cannot be detached, nor can they go about outside of substances, as the sensible species of the Scholastics once did. Thus, neither substance nor accident can enter a monad from without.*" Leibniz posited that essences exist both in the divine intellect and as limitations of the infinite essence of God. Leibniz believed that possible worlds are constituted by individual substances. When God creates the world, he

selects one of these possible worlds—the most perfect one—to actualize. These possible worlds consist of individual essences, each endowed with a degree of reality or perfection. The very existence of a genuinely possible thing implies the existence of an individual essence that can be created.

See Gottfried Leibniz: Philosophy of Mind

And Self and Identity

And 6 Leibniz on the Idea and the Concept of the Self: Inner Sentiment, Self-Knowledge, and the Awakening of Metaphysical Ideas

And 10 Leibniz: Innate Ideas, Reflection, and Self-Knowledge

And Leibniz on Possibilia, Creation, and the Reality of Essences

And Philosophy_of_self (Wikipedia)

And Leibniz and the Shelf of Essence (.pdf)

v Isaac Newton a devout Christian believed in a monotheistic God. Early on, he was a theologian at Trinity College. Newton

concluded that a simple and authentic form of Christianity had been corrupted over the centuries. He believed that the orthodox notion of the Trinity was a fiction invented in the early fourth century and promoted by those who served the devil. According to his views, it was idolatry to give any being the worship rightfully due to God. While he considered Jesus divine, he did not equate Jesus with God. God was the master creator. Humans, the self was a creation of God. The self gets its identity from God.

See Isaac Newton

And Religious views of Isaac Newton

And Newton's Religious Life and Work

And Newton's Metaphysics of Space as God's Emanative Effect

Newton writes of God, "*He endures always and is present everywhere, and by existing always and everywhere he constitutes duration and space. Since each and every particle of space is always, and each and every indivisible moment of duration is everywhere, certainly the maker and lord of all things will not be never or nowhere … God is one and the same God always and everywhere. He is omnipresent not only virtually but also substantially; for active power cannot subsist without substance.*"

Newton, Isaac, 1999, The Principia: Mathematical Principles of Natural Philosophy, I.B. Cohen and A. Whitman (trans.), Berkeley: University of California Press. Page 941.

vi The Enlightenment, also known as the Age of Reason, was a transformative period in Europe and North America from the late 17th

century to the late 18th century. During this time, new approaches in philosophy, science, and politics emerged. The Enlightenment celebrated the human capacity for reason. Philosophers believed that reason was the tool through which knowledge could be extended, individual liberty maintained, and happiness secured. Unlike the Middle Ages, where received wisdom went unchallenged, Enlightenment thinkers questioned everything. They were often referred to as "*free-thinkers*" because they challenged accepted beliefs and sought rational answers. The roots of the Enlightenment can be traced back to the Renaissance (1400-1600) and the humanist movement. Humanists emphasized civic virtue and the realization of an individual's full potential for the benefit of society. The Protestant Reformation (1517-1648) also played a role by diminishing the traditional power of the Christian Church. Enlightenment thinkers sought greater religious freedom and toleration. Enlightenment philosophers engaged in a battle of reason against emotion, superstition, and fear. They applied reason to age-old questions: How should we live together in societies? What is the best form of government? What constitutes happiness?

Their optimism for a better world and the freedom to question everything fueled this intellectual revolution. While the Enlightenment wasn't a single, self-conscious movement, it did introduce innovative themes of thought. But Enlightenment ended with the British empiricists. Philosophers like John Locke conceived of the human mind as a "tabula rasa" (blank slate) upon which experience wrote freely. Locke was an empiricist and believed that all knowledge is derived from sensory experiences. He argued that there is no continuous, unchanging self or soul. Instead, we are a bundle of experiences—a collection of perceptions that constantly change. George Berkeley was another empiricist, extending Locke's ideas. He proposed that the material world exists only through perception. In other words, things exist because they are perceived by minds (including God's mind). Berkeley's view challenges the notion of an independent, substantial soul. Instead, he emphasized the importance of mental experiences. David Hume further developed empiricism. He rejected the idea of a permanent self or soul. According to Hume, our sense of self arises from a stream of consciousness, where experiences flow continuously. Hume famously stated that when he introspected, he found only a bundle of perceptions, not a substantial self or soul. Individual character was shaped by personal experiences in the world. The Enlightenment was a contested ground for ideas of selfhood, oscillating between materialist and idealist conceptions of the self. It occurred against the backdrop of increased individual agency in society. At the end of Enlightenment, we see that already classical and scholastic notions of the self and the soul had begun emptying themselves

out into the certainty of neutrality. The historic 'thrill had gone' and but the relatedness to truth was now based on neutrality of nature and the universe.

See 4.2.3 Empiricism

And The Soul as an Idea in Ancient Greece 101: Epicurus' Soul Atoms

And Soul Religion and Philosophy (Britannica)

And The Enlightenment

And Enlightenment European History (Britannica)

And Self-Enlightenment

And World Literature: The Enlightenment

vii From Hegel, phenomenology of consciousness is the exposition of the coming to be of all knowledge. But phenomenology of consciousness is a precondition of Hegels "Logic", the "Science of Logic". The Logic proceeds in terms of dialectic. Dialectical oppositions necessitate increasingly higher principles transforming and at the same time maintaining oppositional tensions. This process continues until the subject of all predicates is Concept. Concept is completion, perfection, and essence. Concept is universal and absolute fulfillment of the dialectic of Logic. Some Hegelians will tell us is this not hierarchical but horizontally, organically developed as autopoiesis. Autopoiesis originates from the field of systems theory and refers to self-creation or self-production. Autopoiesis is how self-referential structures emerge and develop. Autopoiesis, in this context, reflects the unity-in-difference of matter and life, reality and ideality, nature and thinking. Operational closure is a condition for the openness of a system. It allows for teleological functioning, as systems strive toward specific states. Hegel's notion of the organism as the "unity of inner and outer" exemplifies this minimal self-relating. It is a fundamental form of life where the boundary between inside and outside emerges. Autopoiesis acts as a logical bootstrap: a network produces entities that create their own boundaries. When completed, these entities self-distinguish and bootstrap themselves out of the soup of chemistry and physics. Despite the opposition between modern scientific discourse and Hegelian speculative philosophy, these Hegelian's concepts of autopoiesis bridges the gap between science, physics, and philosophy. Hegel's system provides a unique lens to analyze the relationship between operational closure and the autonomy of living organizations. Perhaps Hegel's system is the highest possible statement of classicism's narratives, of the unity of knowledge and its organic embeddedness. But Hegel's system stops at the interruption of quantum physics from classicism's branching from the spooky exteriority of the

quantum wave function.

See The Phenomenology of Spirit (Wikipedia)

And 6 Spirit in the Phenomenology of Spirit

And Hegel's Phenomenological Method

And Hegel's Phenomenological Method and the Later Movement of Phenomenology

And An Introduction to Hegel's PHENOMENOLOGY OF SPIRIT, complete, in 9 Lectures and 36 Videos

And Selected Works of G.W.F. Hegel: Science of Logic

And Hegel's Phenomenology: On the Logical Structure of Human Experience

And Hegel and Husserl on Phenomenology, Logic, and the System of Sciences: A Reappraisal

And Autopoietic Systems Theory within Hegelian Speculative Philosophy

And AUTOPOIESIS AND LIFE IN HEGEL'S SCIENCE OF LOGIC

And Narrativity and Self-Creating Forms: Autopoiesis in Perspective

And Ecological Ethics and Living Subjectivity in Hegel's Logic. The Middle Voice of Autopoietic Life

3. PHUSIS: TOWARDS RADICAL EXTERIORITY AS PHILOSOPHY

i It interesting to note that chaos in ancient Greece was not our idea of an 'it', as neuter.

On my reading, the most important aspect of Chaos is that it is distinctly nonmale. Although grammatically neuter, Chaos is either characterized as female, a gender-neutral deity,[23] or a "sexually indeterminate figure."[24] An aspect of Chaos' gender is its ability to generate offspring through parthenogenesis. Chaos introduces its characteristic indefinable obscurity into the world through its progeny Erebos and Night (Nux), who are begotten through self-differentiation.[25] This parthenogenetic production introduces children that reiterate the features of their parent. In contrast, through sexual union, Night and Erebos produce children who represent a greater degree of definition in the figuration of Brightness.

(Aither) and Day (Hêmeros),[26] a procreation that points to the way that Hesiod uses sexual generation as a driving force

behind the progression of the succession myth, as I expand upon below. I argue that Chaos begins as a disordered force, which contrasts with the ordering male forces that follow and through the introduction of sexual generation it too is

responsible for the introduction of an embryonic form of order.

Gastêr, Nêdys, and Thauma: Feminine Sources of Deception and Generation in Hesiod's Theogony (.pdf) by Kaitlyn Boulding

Also On Origin | Musings (mixermuse.com)

It is hard for us at the later time in history to understand that the ancient Greeks did not have a notion of 'it' like we do. The Greeks were animists. Everything had soul, animation.

While the myths of the ancient Greeks indicate a kind of animate vitalization of phusis as we see in the pantheon of gods, the notion of 'neuter' in ancient Greek was 'neither one or the other' as in 'not masculine or feminine'. The neuter was the 'not' in ancient Greek of gender. The negative does not specify a positive term as modern usage does of the 'it' (i.e., substance, inanimate objects, not alive, thing, etc.). On Origin | Musings (mixermuse.com)

There were no "its' in the ancient Greek world but there was "neither male nor female". The term "neuter" has an interesting etymology. It originates from Latin, where it means "of the neuter gender"—literally, "neither one nor the other." This concept of neutrality applies to nouns, pronouns, and verbs. In grammar, a neuter noun or pronoun is neither masculine nor feminine in gender, while a neuter verb has middle or reflexive meaning, neither active nor passive. Interestingly, the Latin word "neuter" is likely a loan-translation from the Greek term "*oudeteros*," which also means "neither." This linguistic borrowing highlights the interconnectedness of languages, and the way ideas travel across cultures and time. So, whether in Greek or Latin, the concept of "neuter" reflects a state of being neither one thing nor the other.

See Ancient Greek I - Nouns, Pronouns, and their Case Functions (openbookpublishers.com)

neuter (adj.) – late 14c., of grammatical gender, "neither masculine nor feminine," from Latin neuter "of the neuter gender," literally "neither one nor the other," from ne- "not, no" (from PIE root *ne- "not") + uter "either (of two)" (see whether). Probably a loan-translation of Greek oudeteros "neither, neuter." In 16c., it had the sense of "taking neither side, neutral."

See neuter (adj.) (etymonline)

About the Author

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This work is the result of a lifetime of study in physics and philosophy. My academic background includes a degree in Electrical Engineering and also undergraduate and graduate work in philosophy and the humanities.

After spending decades navigating a career in hardware and software development and management while studying philosophy and science, I came to see that the most profoundly valuable pursuits in understanding have nothing to do with making money. I have always tried to orient myself toward the plight of others, yet I, like others, have faced tragedies and made mistakes that live with me every day. “Quanta, Alterity, and Love” is a eBook and series of volumes in part forged in the cruel mines of heartbreak and guilt and my debt to the others I face and the ones I cannot face.

Now at 69, I have reached an understanding that my youthful assumptions and subsequent painful learning eventually led to a focus not on myself, but on the Other. This is the radical responsibility I owe to the Other—a responsibility that exists even before my own pain, predilections, and desires.

I find deep satisfaction in offering the eBook as a free resource. I also offered the three-volume series of hardback and softback books without any personal profit. The cost you see for the series of volumes is for publishers and distributors only. I am very happy to receive no personal profit for this massive undertaking. I love knowledge for its own sake, not for monetary gain. This book represents years of dedication, writing, and constant re-editing to ensure this work is the best, most reliable content I am capable of—rather than a fantasy of my own making. I welcome criticism and advice with thankfulness. I have found the only downside to any kind of feedback is that it makes me better, more informed, and less insistent on my current understandings.

For those who prefer a PDF, there is a free download available on my website **MixerMuse.com** here:

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